University of Mumbai

As per AAU letter No. 399 dated 20th Aug. 2019

No. UG/ 65 of 2019-20

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/131 of 2016-17 dated 9th November, 2016 relating to the revised syllabus as per (CBCS) for Bachelor of Engineering (First Year Engineering (Sem. I to II).

They are hereby informed that the recommendations made by the faculty members of Engineering at its meeting held on 8th May,2019 have been accepted by the Academic Council at its meeting held on 26th July, 2019 **vide** item No. 4.40 and that in accordance therewith, the Revised Syllabus and Scheme for 2019 of **First Year Engineering** (Sem. I & II) as per AICTE model curriculum from the academic year 2019-20. (The same is available on the University's website www.mu.ac.in).

(Dr. Ajay Deshmukh)
REGISTRAR

MUMBAI – 400 032
14th August, 2019

To

The Principals of the affiliated Colleges, and Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.40/26/07/2019

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No. UG/ 65 -A of 2019-20 MUMBAI-400 032 14th August, 2019

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Director, Board of Examinations and Evaluation,
3) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Ajay Deshmukh)
REGISTRAR

AC: Item No. 4.40
Date: 26TH July, 2019

UNIVERSITY OF MUMBAI

Bachelor of Engineering

First Year Engineering (Semester I & II), Revised course

(REV- 2019'C' Scheme) from Academic Year 2019 – 20

(Common for All Branches of Engineering)

Under

FACULTY OF SCIENCE &TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that in the present system, the first year syllabus is heavily loaded and it is of utmost importance that the students entering into the first year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a student to get accustomed to the new environment of a college and to create a bonding between the teacher and a student. In this regard, AICTE has provided a model of Induction Program, which has been accommodated with certain modification and also overall credits proposed by AICTE in their model curriculum.

The present curriculum will be implemented for First Year of Engineering from the academic year 2019-20. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2020-21, for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. Suresh K. Ukarande
Dean (I/C)
Faculty of Science and Technology
Member, Senate Academic Council
Board of Dean's, BOEE, RRC
University of Mumbai, Mumbai

Structure for

Student Induction Program

New students enter an institution with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

Transition from school to university/college life is one of the most challenging events in student's life. Therefore, it should be taken seriously, and as something more than the mere orientation program.

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

New students be informed that the Induction is mandatory non-credit course for which a certificate will be issued by the institution.

At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The different activities are:

1. **Orientation**: In the first session of Induction program learners and parents to be oriented about institute policies, processes, practices, culture and values. In addition to this, learners will be educated for 1st year academic program information in terms of academic calendar, Assessment plan, grading information, university ordinances, rules and regulations related to academics.

2. **Mentoring**: Mentoring and connecting the students with faculty members is the most important part of student induction. Mentoring process shall be carried out in small groups, group of 10 students to be formed and allocate one senior student from 3rd year of same program in which new students have taken admission, students mentor will continue for two years, till student mentors graduate from the institute. For two (2) such groups one faculty mentor to be allocated from the same department/program, who will remain the mentor till those students graduates from the institute. In the second session of Induction program, groups for mentoring to be formed and student mentors and faculty mentors to be introduced to newly inducted students. Introduction of mentoring system to be given to new students. Minimum one meeting to be

conducted every month during semesters with students group by faculty mentors. For record keeping appropriate formats to be developed and information to be updated regularly by faculty mentors.

3. **Universal Human Values**: Universal Human Values gets the student to explore oneself and experience the joy of learning, prepares one to stand up to peer pressure and take decisions with courage, be aware of relationships and be sensitive to others, understand the role of money in life and experience the feeling of prosperity. Need for character building has been underlined by many thinkers, universal human values provide the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but by getting the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.

4. **Proficiency Modules**: The induction program period can be used to overcome some critical lacunas that students might have, for example, English, Mathematics, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially.

   A diagnostic test should be conducted on Day 2 itself. Before the test, the students should be informed that the test would not affect their grades, branch change, or any aspect of their admission, placement, study, etc. Purpose of the test is to provide help to those students who need help in English, Mathematics, Computer proficiency etc. Students having more than 80% marks in their qualifying examination in respective subjects need not take the diagnostic test. For those below this cut-off, writing the test is mandatory. Students with weak performance in the test, must attend a non-credit course in Basic English, Basic Mathematics, and Basic Computer Operation etc. Their attending the course is mandatory. There would be no separate fee payable for the course. The classes of Basic courses must start from Day 4 at the latest. Students those who are excluded from basic courses, for them some activity in the domain of creative arts, cultural and literature to be organised.

5. **Physical Activity**: Fitness session, yoga classes, lecture(s) on facing world with sportsman spirit, making young students aware that there is nothing like being failure in the world. The world gives opportunities to all.

   The incoming students must be divided into batches of 50 students maximum, and a qualified coach in physical education/ faculty member should be attached to each batch. The list of available games, sport, or physical activities should be announced in orientation program on Day 1. They should be asked to fill their choice with three preferences, and the game or sport be allotted to them as per their preference. The physical activity should start from Day 3 onwards, wherein the student learns and plays his assigned game during the induction program. It is also important that along with his assigned game the student also practises yoga.

6. **Creative Arts, Cultural and Literary Activity**: Qualified instructors for arts may be hired on contract basis and be paid honorarium as per norms of the institute. Daily 90 to 120 minute sessions may be arranged. The list of available art forms, such as vocal music, instrumental music, folk music, painting, sketching, dance, group dance, clay modelling, pottery, dramatics, etc. should be announced. They should be asked to fill their choice with three preferences, and the art form be allotted to them as per their preference. There should be sufficient number of teachers for each art form. The ratio may be kept as 1 teacher for every 25 students.

   A faculty member interested in literary activity should be assigned for organizing the activity. A list of books which are interesting and educational should be prepared beforehand. Books in Indian languages must be included and even given priority. Students are losing connection with languages in general and their own language, in particular. Students should be assigned a book or other smaller reading material. They should be asked to read and write a critical summary. They should present their summary in front of their group. A literary group may consist of around 30-40 students. Similarly, debating and public speaking activity could also be undertaken. If the college can arrange for a drama workshop where a group of students learn and enact a play it would be very good. Not all the incoming students would do this, but those who wish may be provided the opportunity. Help may be taken from senior students engaged in such extra-curricular activities in the college.

7. **Familiarisation with Institute and Department**: The students admitted in a branch would visit their allotted department or branch. The Head of the department and other associated faculty should address the new student's right on Day 2 or so. Arrangements should be made about the meeting/gathering. The parents of the students should also be welcomed if they accompany their ward. It would be helpful if an alumnus of the Dept. relates his professional experience related to the field of the study to the incoming students.

8. **Lectures /Workshops by Eminent People**: Eminent people from all walks of life may be invited to deliver lectures, namely, from industry, academia, social science (authors, historians), social work, civil society, alumni etc. be identified and invited to come and address the new students. Motivational lectures about life, meditation, etc. by Ramakrishna Mission, Art of Living, S-VYASA university, VivekanandKendras, etc. may be organized. Workshops which rejuvenate or bring relief to students would also be welcome, such as, Art of Living workshops.

9. **Extra-Curricular Activity**: Every college has extra-curricular activities. Most of them are student driven. They are organized by student councils and clubs. The extra-curricular activities going on in the college should be presented to the new students under the guidance of faculty advisors for such activity. The new students should be informed about how they can join the activities. Related facilities should be described to them. Presentation on the activities by the student council should be made.

10. **Feedback and Report on the Program**: A formal feedback at the end of the program should be collected from students by their filling a form in writing or online. Besides the above, each group (of 20 students) should write a report on the Induction Program towards the end of the semester. They would also have to make a presentation of their report. They should be encouraged to use slides while making a presentation. Presentation of the report should be made in the language they are comfortable with, without any insistence that it should be in English. It is more important that they feel comfortable and confident. Each group may make the presentation through 4-5 of its group members or more. In case, the number of new students in a college is large, the presentation should be made by each group in front of 4 other groups besides their own, thus there would be about 100 students (in 5 groups) in the audience in a session. Several such sessions could run in parallel or serially. In each session, their faculty mentors and student guides, if any, should also be in the audience. These sessions would tell you how well the program ran, and what the students are feeling at the end of the program. This would also serve as a grand closure to the program.

    A certificate shall be awarded to all the students, upon successful completion of the induction program based on their report and presentation.

Tentative schedule of 1st Week Induction Program:

Day 1	Session 1	Orientation program
	Session 2	Mentoring (group formation and introduction)
Day 2	Session 3	Diagnostic test (basic English, maths and computer operation)
	Session 4	Familiarisation of Department and Institute (Visits to department, laboratory, Library, Examination cell, office etc)
Day 3	Session 5	Physical Activity (Yoga, sports etc)
	Session 6	Universal human values session
Day 4	Session 7	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 8	Physical Activity (Yoga, sports etc)
Day 5	Session 9	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 10	Creative Arts, Cultural and Literary Activity

A session may be conducted for around 2-3 hours each.

Minimum 12 sessions to be conducted from the following 20 sessions, from 2nd week to last week of academics, throughout the semester.

Session 11	Physical Activity (Yoga, sports etc)- 1
Session 12	Extra-Curricular Activity- 1
Session 13	Physical Activity (Yoga, sports etc)-2
Session 14	Extra-Curricular Activity- 2
Session 15	Physical Activity (Yoga, sports etc)- 3
Session 16	Lectures /Workshops by Eminent People- 1
Session 17	Physical Activity (Yoga, sports etc)- 4
Session 18	Lectures /Workshops by Eminent People- 2
Session 19	Creative Arts, Cultural and Literary Activity- 1
Session 20	Lectures /Workshops by Eminent People- 3
Session 21	Creative Arts, Cultural and Literary Activity- 2
Session 22	Universal Human Values- 1(Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 23	Creative Arts, Cultural and Literary Activity- 3
Session 24	Universal Human Values- 2 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 25	Creative Arts, Cultural and Literary Activity- 4
Session 26	Universal Human Values- 3 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 27	Creative Arts, Cultural and Literary Activity- 5
Session 28	Physical Activity (Yoga, sports etc)- 5
Session 29	Feedback and Report on the Program- 1
Session 30	Feedback and Report on the Program- 2

For mentoring activity following 4 page format (may be printed as booklet) be adopted by institute for keeping record in detail of students during 4 year tenure by faculty mentor.

NAME OF INSTITUTE

LOGO OF INSTITUTE

Student Mentoring Form

Student's Personal Details	
Name :	Roll No:
Date of Birth:	Male/Female:
Current Address:	
Permanent Address:	
Mobile No:	Email Id:
Father's Name:	
Mobile No.:	Email ID.:
Mother's Name	
Mobile No.:	Email ID.:
Name of The Student Mentor:	
Mobile No.:	Email ID.:
Name of The Faculty Mentor:	
Designation:	Department.:

Student's Attendance Record

Semester	Month / Year :		Month / Year :		Month / Year :	
	Percentage	Signature	Percentage	Signature	Percentage	Signature
I						
II						
III						
IV						
V						
VI						
VII						
VIII						

Student's Academic Performance

Semester	Subject	IA1		IA 2		Prelim		End semester Exam (SGPI)		Signature
I	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
II	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
III	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
IV	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
V	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
VI	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
VII	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									
VIII	Performance	C	N/C	C	N/C	C	N/C	C	N/C	
	Remark									

Note.:

1. C - Cleared, write percentage or SGPI in Remarks.
2. N/C - write subjects not cleared in Remarks.
3. If students cleared subjects in next academic year kindly circle “N/C” and click On “C”

Student's Co-curricular Activities

Semester	Professional Society	Internship	Papers Published
I			
II			
III			
IV			
V			
VI			
VII			
VIII			

Student Mentor’s Feedback Semester wise

Semester I	Semester II	Semester III	Semester IV

Student's Extra-Curricular Activities

Semester	Sports	NSS / Social cell	Competition / Participation / Prize / Awards
I			
II			
III			
IV			
V			
VI			
VII			
VIII			

Placement: - Yes / No If yes get following Details:

Company :-
Package :-

Higher Studies.

Exams	GRE	TOFEL	CAT	GATE
SCORE				

If Admitted:-

University :-
Country :-

Program Structure for First Year Engineering
Semester I & II
UNIVERSITY OF MUMBAI
(With Effect from 2019-2020)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
FEC101	Engineering Mathematics-I	3	--	1*	3	--	1	4
FEC102	Engineering Physics-I	2		--	2		--	2
FEC103	Engineering Chemistry-I	2	--	--	2	--	--	2
FEC104	Engineering Mechanics	3	--	--	3	--	--	3
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3
FEL101	Engineering Physics-I	--	1	--	--	0.5	--	0.5
FEL102	Engineering Chemistry-I	--	1	--	--	0.5	--	0.5
FEL103	Engineering Mechanics	--	2	--	--	1	--	1
FEL104	Basic Electrical Engineering	--	2	--	--	1	--	1
FEL105	Basic Workshop practice-I	--	2	--	--	1	--	1
Total		**13**	**08**	**01**	**13**	**04**	**01**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC101	Engineering Mathematics-I	20	20	20	80	3	25	--	125
FEC102	Engineering Physics-I	15	15	15	60	2	--	--	75
FEC103	Engineering Chemistry-I	15	15	15	60	2	--	--	75
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100
FEL101	Engineering Physics-I	--	--	--	--	--	25	--	25
FEL102	Engineering Chemistry-I	--	--	--	--	--	25	--	25
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50
FEL105	Basic Workshop practice-I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**90**	**360**	**--**	**175**	**50**	**675**

*** Shall be conducted batch-wise**

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
FEC201	Engineering Mathematics-II	3	--	1*	3	--	1	4
FEC202	Engineering Physics-II	2	--	--	2	--	--	2
FEC203	Engineering Chemistry-II	2	--	--	2	--	--	2
FEC204	Engineering Graphics	2	--	--	2	--	--	2
FEC205	C programming	2	--	--	2	--	--	2
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2
FEL201	Engineering Physics-II	--	1	--	--	0.5	--	0.5
FEL202	Engineering Chemistry-II	--	1	--	--	0.5	--	0.5
FEL203	Engineering Graphics	--	4	--	--	2	--	2
FEL204	C programming	--	2	--	--	1	--	1
FEL205	Professional Communication and Ethics- I	--	2	--	--	1	--	1
FEL206	Basic Workshop practice-II	--	2	--	--	1	--	1
Total		**13**	**12**	**01**	**13**	**06**	**01**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75
FEC205	C programming	15	15	15	60	2	--	--	75
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75
FEL204	C programming	--	--	--	--	--	25	25	50
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25
FEL206	Basic Workshop practice-II	--	--	--	--	--	50	--	50
Total		**--**	**--**	**90**	**360**	**--**	**200**	**75**	**725**

*** Shall be conducted batch-wise**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC201	Engineering Mathematics-I	3	--	1*	3	1	--	4

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-I	20	20	20	80	3	25	--	125

Course Objectives: The course is aimed

1. to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.
2. to provide hands on experience using SCILAB software to handle real life problems.

Course Outcomes: Students will be able to

1. Apply the basic concepts of Complex Numbers and will be able to use it for engineering problems.
2. Apply hyperbolic functions and logarithms in the subjects like electrical circuits, Electromagnetic wave theory.
3. Apply the basic concepts of partial differentiation of function of several variables and will be able to use in subjects like Electromagnetic Theory, Heat and Mass Transfer etc.
4. Apply the concept of Maxima, Minima and Successive differentiation and will be able to use it for optimization and tuning the systems.
5. Apply the concept of Matrices and will be able to use it for solving the KVL and KCL in electrical networks.
6. Apply the concept of Numerical Methods for solving the engineering problems with the help of SCILAB software.

Module	Detailed Contents	Hrs.
01	**Complex Numbers** **Pre-requisite:**Review of Complex Numbers-Algebra of Complex Number, Cartesian, polar and exponential form of complex number. 1.1. Statement of **D'Moivre's Theorem**. 1.2. Expansion of $\sin^n\theta$, $\cos^n\theta$ in terms of sines and cosines of multiplesof θ and Expansion of sinnθ, cosnθ in powers of sinθ, cosθ 1.3. Powers and Roots of complex number.	**2** **2** **2**
02	**Hyperbolic function and Logarithm of Complex Numbers** 2.1. Circular functions of complex number and Hyperbolic functions. Inverse Circular and Inverse Hyperbolic functions. Separation of real and imaginary parts of all types of Functions. 2.2 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions. **# Self learning topics:**Applications of complex number in Electrical circuits.	**4** **2**

03	**Partial Differentiation** 3.1 Partial Differentiation: Function of several variables, Partial derivatives of first and higher order. Differentiation of composite function. 3.2.Euler's Theorem on Homogeneous functions with two independent variables (with proof). Deductions from Euler's Theorem. **# Self learning topics:**Total differentials,implicit functions, Euler's Theorem on Homogeneous functions with three independent variables.	**3** **3**
04	**Applications of Partial Differentiation and Successive differentiation.** 4.1 Maxima and Minima of a function of two independent variables, Lagrange's method of undetermined multipliers with one constraint. 4.2 Successive differentiation: nth derivative of standard functions. Leibnitz's Theorem (without proof) and problems **# Self learning topics:** Jacobian's of two and three independent variables (simple problems)	**3** **3**
05	**Matrices** **Pre-requisite:** Inverse of a matrix, addition, multiplication and transpose of a matrix 5.1.Types of Matrices (symmetric, skew- symmetric, Hermitian, Skew Hermitian, Unitary, Orthogonal Matrices and properties of Matrices). Rank of a Matrix using Echelon forms, reduction to normal form and PAQ form. **5.**2.System of homogeneous and non –homogeneous equations, their consistency and solutions. **# Self learning topics:**Application of inverse of a matrix to coding theory.	**4** **2**
06	**Numerical Solutions of Transcendental Equations and System of Linear Equations and Expansion of Function.** 6.1 Solution of Transcendental Equations: Solution by Newton Raphson method and Regula –Falsi method. 6.2 Solution of system of linear algebraic equations, by (1) Gauss Jacobi Iteration Method, (2) Gauss Seidal Iteration Method. 6.3 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only). Expansion ofe^x sin(x), cos(x), tan(x), sinh(x), cosh(x), tanh(x), log(1+x),$\sin^{-1}(x)$,$\cos^{-1}(x)$,$\tan^{-1}(x)$. **# Self learning topics:**Indeterminate forms, L- Hospital Rule, Gauss Elimination Method, Gauss Jordan Method.	**2** **2** **2**

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write at least 4 SCILAB tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SCILAB Tutorials will be based on (i) Guass Elimination Method (ii) Guass Seidal Iteration method (iii) Gauss Jacobi Iteration Method (iv) Newton Raphson Method (v) Regula –Falsi method (vi) Maxima and Minima of functions of two variables

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	SCILAB Tutorials	10 marks

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hoursas mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Engineering Mathematics by Srimanta Pal and Subodh,C.Bhunia, Oxford University Press
4. Matrices, Shanti Narayan, .S. Chand publication.
5. Applied Numerical Methods with MATLABfor Engineers and Scientists by Steven Chapra, McGraw Hill
6. Elementary Linear Algebra with Application by Howard Anton and Christ Rorres. 6th edition. John Wiley & Sons,INC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC102	Engineering Physics-I	2	-	-	2	-	-	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC102	Engineering Physics-I	15	15	15	60	2	--	--	75

Rationale:

Most of the engineering branches are being off-spring of basic sciences where physics is playing a pivotal role in concept and understanding of foundation of core engineering branches. This syllabus is developed by keeping in mind, needs of all branches that we offer in University of Mumbai.

The topic distribution is being done in systematic manner and whenever required, prerequisite to the topic are mentioned for frictionless teaching–learning process. In the distribution of topics, core physics and its applied form are given priority. At the same time few modules are introduced over emerging trends in the field of technology.

For the purpose of emphasis on applied part, list of suggestive experiments is added. As per new guidelines of AICTE, a scope is kept in the syllabus for simulation technique and use of information technology to supplement laboratory practices. Further, it is ensured that these modules will cover prerequisites needed for engineering courses to be introduced in higher semesters as core subjects or as interdisciplinary subjects in respective branches.

Objectives

1. To understand basic physics concepts and founding principles of technology.
2. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.

Outcomes: Learners will be able to…

1. Illustrate the fundamentals of quantum mechanics and its application.
2. Explain peculiar properties of crystal structure and apply them in crystallography using X-ray diffraction techniques.
3. Comprehend the concepts of semiconductor physics and applications of semiconductors in electronic devices.
4. Employ the concept of interference in thin films in measurements.
5. Discuss the properties of Superconductors and Supercapacitors to apply them in novel applications.
6. Compare the properties of engineering materials for their current and futuristic frontier applications.

Module	Detailed Contents	Hrs.
01	**QUANTUM PHYSICS** (**Prerequisites** : Dual nature of radiation, Photoelectric effect Matter waves-wave nature of particles, de-Broglie relation, Davisson-Germer experiment)	07

	De Broglie hypothesis of matter waves; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg uncertainty principle; non existence of electron in nucleus; Schrodinger's time dependent wave equation; time independent wave equation; Particle trapped in one dimensional infinite potential well, Quantum Computing.	
02	**CRYSTALLOGRAPHY** (**Prerequisites** : Crystal Physics (Unit cell, Space lattice, Crystal structure, Simple Cubic, Body Centered Cubic, Face Centered Cubic, Diamond Structure, Production of X-rays) Miller indices; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer;	**03**
03	**SEMICONDUCTOR PHYSICS** (**Prerequisites**: Intrinsic and extrinsic semiconductors, Energy bands in conductors, semiconductors and insulators, Semiconductor diode, I-V characteristics in forward and reverse bias) Direct & indirect band gap semiconductor; Fermi level; Fermi dirac distribution; Fermi energy level in intrinsic & extrinsic semiconductors; effect of impurity concentration and temperature on fermi level; mobility, current density; Hall Effect; Fermi Level diagram for p-n junction (unbiased, forward bias, reverse bias); Applications of semiconductors: LED, Zener diode, Photovoltaic cell.	**06**
04	**INTERFERENCE IN THIN FILM** (**Prerequisites** : Wave front and Huygen's principle, reflection and refraction, Interference by division of wave front, Youngs double slit experiment) Interference by division of amplitude, Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film; Newton's rings. Applications of interference - Determination of thickness of very thin wire or foil; determination ofrefractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surfaceflatness; Anti-reflecting films and Highly reflecting film.	**06**
05	**SUPERCONDUCTORS AND SUPERCAPACITORS** (**Prerequisites :** Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current, Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical resistivity and conductivity temperature dependence of resistance) Superconductors: Critical temperature, critical magnetic field, Meissner's effect, Type I and Type II and high Tc superconductors; Supercapacitors: Principle, construction, materials and applications, comparison with capacitor and batteries : Energy density, Power density,	**02**
06	**ENGINEERING MATERIALS AND APPLICATIONS** (**Prerequisites:** Paramagnetic materials, diamagnetic materials, ferromagnetic materials, crystal physics, Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarisation, capacitors and capacitance) Liquid crystals: Nematic, Smectic and cholesteric phases, Liquid crystal display. Multiferroics : Type I & Type II multiferroics and applications,	**02**

	Magnetoresistive Oxides: Magnetoresistance, GMR and CMR materials, introduction to spintronics.	

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
5. Modern Engineering Physics – Vasudeva, S.Chand
6. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
7. A Text Book of Engineering Physics, S. O. Pillai, New Age International Publishers.
8. Introduction to Solid State Physics- C. Kittle, John Wiley& Sons publisher
9. Ultracapacitors: The future of energy storage- R.P Deshpande, McGraw Hill
10. Advanced functional materials – AshutoshTiwari, LokmanUzun, Scrivener Publishing LLC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC103	Engineering Chemistry-I	02	-	-	02	-	-	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC103	Engineering Chemistry-I	15	15	15	60	2	--	--	75

Objectives

1. The concepts developed in this course will aid in quantification as well as understand the applications of several concepts in Chemistry that have been introduced at the 10 + 2 levels in schools.

Outcomes: Learners will be able to…

1. Explain the concept of microscopic chemistry in terms of atomic and molecular orbital theory and relate it to diatomic molecules.
2. Describe the concept of aromaticity and interpret it with relation to specific aromatic systems.
3. Illustrate the knowledge of various types of intermolecular forces and relate it to real gases.
4. Interpret various phase transformations using thermodynamics.
5. Illustrate the knowledge of polymers, fabrication methods, conducting polymers in various industrial fields.
6. Analyze the quality of water and suggest suitable methods of treatment.

Module	Detailed Contents	Hrs.
01	**Atomic and Molecular Structure** Atomic orbitals (s,p,d,f) orbital shapes, Electronic Configuration, Molecular orbital theory (MOT), bonding and anti-bonding orbitals, Molecular orbital diagrams of Homonuclear and Heteronuclear diatomic molecules-Be_2, O_2, CO, NO their bond order and magnetic properties,	**04**
02	**Aromatic systems &their molecular structure** Define Aromaticity, Huckel's rule, Structure and bonding of benzene and pyrrole.	**02**
03	**Intermolecular Forces & Critical Phenomena** Ionic, dipolar and Vander Waal's interactions, Equations of state of real gases and critical phenomena	**03**
04	**Phase Rule-Gibb's Phase Rule** Statement of Gibbs' Phase Rule, Terms involved with examples, One Component System (Water), Reduced Phase Rule, Two Component System (Pb- Ag), Advantages and Limitations of Phase Rule. Numerical problems on Phase Rule.	**05**

05	**Polymers** Introduction: Definition- Polymer, polymerization, Properties of Polymers- Molecular weight (Number average and Weight average), Numerical problems on molecular weight, effect of heat on polymers (glass transition temperature), Viscoelasticity,Conducting Polymers, Classification-Thermoplastic and Thermosetting polymers; Compounding of plastic, Fabrication of plastic by Compression, Injection, Transfer and Extrusion moulding, Preparation, properties and uses of PMMA and Kevlar.	**05**
06	**Water** Introduction - Impurities in water, hardness of water- units (no conversions), types and numerical problems, determination of hardness of water by EDTA method and numerical problems.Softening of water by Ion Exchange process and numerical problems, BOD, COD- definition, significance and Numerical problems. Water purification-membrane technology- Electrodialysis, Reverse osmosis, and Ultra filtration.	**05**

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Engineering Chemistry - Jain & Jain (DhanpatRai)
2. Engineering Chemistry – Dara &Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry – ShashiChawla (DhanpatRai)
5. Engineering Chemistry – Payal Joshi &Shashank Deep (Oxford University Press)
6. Concise Inorganic Chemistry – J D LEE
7. Essentials of Physical Chemistry—B S BahlArunBahl G D Tuli.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC104	Engineering Mechanics	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100

Objectives

1. To familiarize the concept of equilibrium and friction
2. To study and analyze motion of moving particles/bodies.

Outcomes: Learners will be able to…

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Demonstrate the understanding of Centroid and its significance and locate the same.
3. Correlate real life application to specific type of friction and estimate required force to overcome friction.
4. Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation
5. Illustrate different types of motions and establish Kinematic relations for a rigid body
6. Analyze particles in motion using force and acceleration, work-energy and impulse-momentum principles

Self-Study/pre-requisites Topics:

Resolution of a forces. Use of trigonometry functions. Parallelogram law of forces. Law of triangle. Polygon law of forces, Lami's theorem. Concepts of Vector Algebra.

Uniformly accelerated motion along straight line, motion under gravity, projectile motion, Time of flight, Horizontal range, Maximum height of a projectile.

Law of conservation of Energy, Law of conservation of Momentum, Collision of Elastic Bodies.

Module	Detailed Contents	Hrs.
01	**1.1 System of Coplanar Forces:** Classification of force systems, Principle of transmissibility, composition and resolution of forces. **1.2 Resultant:** Resultant of coplanar and Non Coplanar (Space Force) force system (Concurrent forces, parallel forces and non-concurrent Non-parallel system of forces). Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane.	**06**
	Centroid: First moment of Area, Centroid of composite plane Laminas	**03**

02	**2.1 Equilibrium of System of Coplanar Forces:** Conditions of equilibrium for concurrent forces, parallel forces and non-concurrent non- parallel general forces and Couples. Equilibrium of rigid bodies-free body diagrams. **2.2 Equilibrium of Beams:** Types of beams, simple and compound beams, type of supports and reaction: Determination of reactions at supports for various types of loads on beams. (Excluding problems on internal hinges)	**04** **03**
03	**Friction:** Revision of Static Friction, Dynamic/ Kinetic Friction, Coefficient of Friction, Angle of Friction, Laws of friction. Concept of Cone of friction. Equilibrium of bodies on inclined plane. Application to problems involving wedges and ladders.	**04**
04	**Kinematics of Particle:** Motion of particle with variable acceleration. General curvilinear motion. Tangential& Normal component of acceleration, Motion curves (a-t, v-t, s-t curves). Application of concepts of projectile motion and related numerical.	**04**
05	**Kinematics of Rigid Body:** Translation, Rotation and General Plane motion of Rigid body. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR for 2 link mechanism. Velocity analysis of rigid body using ICR.	**03**
06	**6.1 Kinetics of a Particle:** Force and Acceleration: -Introduction to basic concepts, D'Alemberts Principle, concept of Inertia force, Equations of dynamic equilibrium, Newton's second law of motion. (Analysis limited to simple systems only.)	**04**
	6.2 Kinetics of a Particle: Work and Energy: Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs.	**04**
	6.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Impact and collision: Law of conservation of momentum, Coefficient of Restitution. Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	**03**

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. 10 percentage of marks will be asked from the self-study topics.
3. Total 04 questions need to be solved.
4. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
5. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

6. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

References:

1. Engineering Mechanics by R. C.Hibbeler.
2. Engineering Mechanics by Beer &Johnston, Tata McGrawHill
3. Engineering Mechanics by F. L. Singer, Harper& RawPublication
4. Engineering Mechanics by Macklin & Nelson, Tata McGrawHill
5. Engineering Mechanics by ShaumSeries
6. Engineering Mechanics by A K Tayal, UmeshPublication.
7. Engineering Mechanics by Kumar, Tata McGrawHill
8. Engineering Mechanics (Statics) by Meriam and Kraige, WileyBools
9. Engineering Mechanics (Dynamics) by Meriam and Kraige, WileyBools

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100

Objectives

1. To provide knowledge on fundamentals of D.C. circuits and single phase and three phase AC circuits and its applications.
2. To inculcate knowledge on the basic operation and performance of 1-Φ transformer.
3. To provide knowledge on fundamentals of DC and AC machines.

Outcomes: Learner will be able to…

1. Apply various network theorems to determine the circuit response / behavior.
2. Evaluate and analyze 1-Φ circuits.
3. Evaluate and analyze 3-Φ AC circuits.
4. Understand the constructional features and operation of 1-Φ transformer.
5. Illustrate the working principle of 3-Φ machine.
6. Illustrate the working principle of 1-Φ machines.

Module	Detailed Contents	Hrs.
Prerequisite	Resistance, inductance, capacitance, series and parallel connections of resistance, concepts of voltage, current, power and energy and its units. Working of wattmeter, Magnetic circuits, MMF, Magnetic field strength, reluctance, series and parallel magnetic circuits, BH Curve, Time domain analysis of first order RL and RC circuits	--
01	DC Circuits: (Only independent source) Kirchhoff's Laws, Ideal and practical Voltage and current Sources, Source Transformation, Mesh and Nodal Analysis, Star-Delta / Delta-Star Transformations, Superposition, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.	**12**
02	AC Circuits :Generation of alternating voltage, basic definitions, average and r.m.s values, phasor and phase difference, sums on phasors, Single-phase ac series and parallel circuits consisting of R, L, C, RL, RC, RLC combinations, definitions - real, reactive and apparent power, admittance (Y), Series and parallel resonance, Q factor	**10**
03	Generation of Three-Phase Voltages, voltage & current relationships in Star and Delta Connections, power measurement in three phase balanced circuit(Only two wattmeter method).	**04**

04	Transformers: Working principle of single-phase transformer, EMF equation of a transformer, Transformer losses, Actual (practical) and ideal transformer, Phasor diagram (considering winding resistance and magnetic leakage), Equivalent circuit, Open-circuit test (no-load test), short circuit (SC) test, efficiency.	**06**
05	Electrical Machines (Numerical not expected): Rotating magnetic field produced by three phase ac, principle of operation of Three-phase induction motor, constructional details and classification of Induction machines.	**02**
06	Principle of operation of Single-Phase induction motors, stepper motor (Single stack variable reluctance and permanent magnet) (Numerical not expected)	**02**
Self-study Topic	Principle of operation of DC generators and DC motors, constructional details and classification of DC machines, e.m.f equation of generator/motor, applications. (Theory question can be asked in University exam, no numericals. The percentage of marks allotted should be maximum of 10% (max. 08marks))	--

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20marks.
2. Total 04 questions need to besolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will beasked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books:

1. V. N. Mittal and Arvind Mittal "Basic Electrical Engineering" Tata McGraw Hill, (Revised Edition)
2. Vincent Del Toro "Electrical Engineering Fundamentals", PHI Second edition, 2011
3. Edward Hughes "Hughes Electrical and Electronic Technology", Pearson Education (Tenth edition)
4. D P Kothari and I J Nagrath "Theory and Problems of Basic Electrical Engineering", PHI 13th edition 2011.
5. M. Naidu,S. Kamakshaiah "Introduction to Electrical Engineering" McGraw-Hill Education, 2004
6. B.R Patil "Basic Electrical Engineering" Oxford Higher Education

References:

1. B.L.Theraja "Electrical Engineering " Vol-I and II.
2. S.N.Singh, "Basic Electrical Engineering" PHI , 2011Book

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL101	Engineering Physics-I	-	01	-	-	-	0.5	0.5

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL101	Engineering Physics-I	--	--	--	--	--	25	--	25

Objectives

1. To improve the knowledge about the theory learned in the class.
2. To improve ability to analyze experimental result and write laboratory report.

Outcomes: Learners will be able to…

1. Perform the experiments based on interference in thin films and analyze the results.
2. Verify the theory learned in the module crystallography.
3. Perform the experiments on various semiconductor devices and analyze their characteristics.
4. Perform simulation study on engineering materials.

Suggested Experiments: (Any five)

1. Determination of radius of curvature of a lens using Newton's ring set up
2. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method.
3. Study of Miller Indices.
4. Study of Hall Effect.
5. Determination of energy band gap of semiconductor.
6. Study of Zener diode as voltage regulator.
7. Study of I/V characteristics of LED
8. Determination of 'h' using Photo cell.
9. Study of I / V characteristics of semiconductor diode
10. Charging and discharging characteristics of supercapacitor.
11. Simulation study of orientational ordering in Nematic like 2D liquid crystal.
12. Simulation experiments based on engineering materials using open source simulation softwares like Avogadro, Chimera, JMOL etc.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) **:** 1**0 marks**
- Project Groupwise (Topic Presentation) **:** **10 marks**
- Attendance (Theory and Tutorial) **:** **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL102	Engineering Chemistry-I	-	01	-	-	-	0.5	0.5

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL102	Engineering Chemistry-I	--	--	--	--	--	25	--	25

Outcomes: Learners will be able to…

1. Determine Chloride content and hardness of water sample
2. Determine free acid ph of different solutions
3. Determine metal ion concentration
4. Synthesize polymers, biodegradable plastics.
5. Determine Viscosity of oil

Suggested Experiments:

1. To determine Chloride content of water by Mohr's Method.
2. To determine total, temporary and permanent hardness of water sample by EDTA method.
3. To determine free acid pH of different solutions using pH meter
4. To determine metal ion concentration using colorimeter.
5. Removal of hardness using ion exchange column.
6. Molecular weight determination of polymers by Oswald Viscometer.
7. Synthesis of UF, PF, Nylon 66.
8. Determination of COD
9. Synthesis of biodegradable polymer using corn starch or potato starch
10. Determination of Viscosity of oil by Redwood Viscometer

Term work:

Term Work shall consist of minimum five experiments.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) **:** 1**0 marks**
- Assignments and Viva on practicals **:** **10 marks**
- Attendance (Theory and Tutorial) **:** **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL103	Engineering Mechanics	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50

Objectives

1. To acquaint the concept of equilibrium in two and three dimensional system.
2. To study and analyse motion of moving particles/bodies.

Outcomes: Learners will be able to…

1. Verify equations of equilibrium of coplanar force system
2. Verify law of moments.
3. Determine the centroid of plane lamina.
4. Evaluate co-efficient of friction between the different surfaces in contact.
5. Demonstrate the types of collision/impact and determine corresponding coefficient of restitution.
6. Differentiate the kinematics and kinetics of a particle.

List of Experiments:

Minimum six experiments from the following list of which minimum one should from dynamics.

1. Verification of Polygon law of coplanar forces
2. Verification of Principle of Moments (Bell crank lever.)
3. Determination of support reactions of a Simply Supported Beam.
4. Determination of coefficient of friction) using inclined plane
5. Verification of the equations of equilibrium for Non-concurrent non-parallel (General) force system.
6. Collision of elastic bodies (Law of conservation of momentum).
7. Kinematics of particles. (Uniform motion of a particle, Projectile motion, motion under gravity)
8. Kinetics of particles. (collision of bodies)

Sr No.	Assignments to be completed during Practical Session.	Minimum Number of Numerical
1	Resultant of Coplanar force system	4
2	Resultant of Non-Coplanar force system	3
3	Centroid of Composite plane Laminas	4
4	Equilibrium of System of Coplanar Forces	4
5	Beam Reaction	4
6	Equilibrium of bodies on inclined plane and problems involving wedges and ladders.	4
7	Kinematics of particles (Variable acceleration + Motion Curves +Projectile motion)	4
8	Kinetics of particles (D'Alemberts Principle, Work Energy Principle, Impulse momentum Principle, Impact and Collisions.)	5

Assessment:

Term Work: It comprises Laboratory Experiments and Assignments.

The distribution of marks for term work shall be as follows:

- Practical Work and Journal : 10 marks.
- Assignments : 10 marks.
- Attendance : 05 Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral examination based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL104	Basic Electrical Engineering	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50

Objectives

1. To impart the basic concept of network analysis and its application.
2. To provide the basic concept of ac circuits analysis and its application.
3. To illustrate the operation of machines and transformer.

Outcomes: Learners will be able to…

1. Interpret and analyse the behaviour of DC circuits using network theorems.
2. Perform and infer experiment on single phase AC circuits.
3. Demonstrate experiment on three phase AC circuits.
4. Illustrate the performance of single phase transformer and machines.

Suggested List of laboratory experiments (Minimum Eight):

Also minimum two experiments from each course outcome shall be covered

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. To measure output voltage across load resistor/current through load resistor and verify the result using Mesh and Nodal analysis.
3. Verification of Superposition Theorem.
4. Verification Thevenin's Theorem.
5. Verification Norton's Theorem.
6. Verification Maximum Power Transfer Theorem.
7. To find the resistance and inductance of a coil connected in series with a pure resistance using three voltmeter method.
8. To find the resistance and inductance of a coil connected in parallel with a pure resistance using three ammeter method.
9. To find resonance conditions in a R-L-C series resonance circuit
10. To find resonance conditions in a R-L-C parallel resonance circuit.
11. To measure relationship between phase and line, currents and voltages in three phase system (star & delta)
12. To measure Power and phase in three phase system by two wattmeter method.
13. To find the equivalent circuit parameters by conducting OC and SC test on single phase transformer
14. To demonstrate cut-out sections of DC machine.
15. To demonstrate cut-out sections of single phase transformer.

Term Work: It comprises both part a and b

Term work consists of performing minimum 06 practical mentioned as below. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal) : 10 marks.
- Assignments : 10marks.
- Attendance (Theory and Practical) : 05Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral examination based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL105	Basic Workshop Practice-I	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL105	Basic Workshop Practice-I	--	--	--	--	--	50	--	50

Objectives

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Outcomes: Learners will be able to…

1. Develop the necessary skill required to handle/use different fitting tools.
2. Develop skill required for hardware maintenance.
3. Able to install an operating system and system drives.
4. Able to identify the network components and perform basic networking and crimping.
5. Able to prepare the edges of jobs and do simple arc welding.
6. Develop the necessary skill required to handle/use different plumping tools.
7. Demonstrate the turning operation with the help of a simple job.

	Detailed Content	**Hrs.**
	Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic at trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work CO-1 is related to Trade-1 CO-2 to CO-4 is related to Trade-2 CO-5 is related to Trade-3 CO-6 is related to Trade-4 CO-7 is related to Trade-5 CO evaluation is to be done according to the opted Trades in addition to **Compulsory Trades.**	
Trade-1	**Fitting (Compulsory):** • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations : filing to size, one simple male- female joint, drilling and tapping	**10**

Trade-2	**Hardware and Networking: (Compulsory)** • Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) • Basic troubleshooting and maintenance • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. NOTE: Hands on experience to be given in a group of not more than four students	**08**
Trade-3	**Welding:** • Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	**06**
Trade 4	**Plumbing:** • Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	**06**
Trade-5	**Machine Shop:** • At least one turning job is to be demonstrated and simple job to be made for Term Work in a group of 4 students.	**06**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC201	Engineering Mathematics-II	3	--	1*	3	1	--	4

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125

Course Objectives

1. The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.
2. To provide hands on experience in using SCILAB software to handle real life problems.

Course Outcomes: Students will be able to…

1. Apply the concepts of First Order and first degree Differential equation to the problems in the field of engineering.
2. Apply the concepts of Higher Order Linear Differential equation to the engineering problems.
3. Apply concepts of Beta and Gamma function to solve improper integrals.
4. Apply concepts of Double integral of different coordinate systems to the engineering problems like area and mass.
5. Apply concepts of triple integral of different coordinate systems to the engineering problems and problems based on volume of solids.
6. Solve differential equations and integrations numerically using SCILAB software to experimental aspect of applied mathematics.

Module	Detailed Contents	Hrs.
01	**Differential Equations of First Order and First Degree** 2.1 Exact differential Equations, Equations reducible to exact form by using integrating factors. 1.2 Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation. **# Self learning topics:**Simple application of differential equation of first order and first degree to electricaland Mechanical Engineering problem	**4** **2**
02	**Linear Differential Equations With Constant Coefficients and Variable Coefficients Of Higher Order** 2.1. Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type f(D)y = X where X is e^{ax}, $\sin(ax+b), \cos(ax+b), x^n, e^{ax}V, x\,V$. 2.2. Method of variation of parameters.	**4** **2**

	# Self learning topics: Cauchy's homogeneous linear differential equation and Legendre's differential equation, Applications of Higher order differential equation.	
03	**Beta and Gamma Function, Differentiation under Integral sign and Rectification** **Pre-requisite:**Tracing of curves **3.1** Beta and Gamma functions and its properties. **3.2** Differentiation under integral sign with constant limits of integration. **3.3** Rectification of plane curves.(Cartesian and polar) **# Self learning topics:**Rectification of curve in parametric co-ordinates.	**2** **2** **2**
04	**Multiple Integration-1** 4.1. Double integration-definition, Evaluation of Double Integrals.(Cartesian & Polar) 4.2. Evaluation of double integrals by changing the order of integration. 4.3. Evaluation of integrals over the given region.(Cartesian & Polar) **# Self learning topics:**Application of double integrals to compute Area, Mass.	**2** **2** **2**
05	**Multiple Integration-2** 5.1. Evaluation of double integrals by changing to polar coordinates. 5.2. Application of double integrals to compute Area 5.3.Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates). **# Self learning topics:** Application of triple integral to compute volume.	**2** **2** **2**
06	**Numerical solution of ordinary differential equations of first order and first degree, and , Numerical Integration** 6.1. Numerical solution of ordinary differential equation using (a) Euler's method (b) Modified Euler method, (c) Runge-Kutta fourth order method 6.2. Numerical integration- by (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule (all with proof). **# Self learning topics:**Numerical solution of ordinary differential equation using Taylor series method.	**3** **3**

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per
   University pattern for practicals.
2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write at least 4 SCILAB tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SCILAB Tutorials will be based on (i) Euler Method, (ii) Modified Euler Method, (iii) Runge-Kutta Method of fourth order , (iv) Trapezoidal Rule , (v) Simpson's $1/3^{rd}$ Rule (vi) Simpson's 3/8th rule

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	: 05 marks
2.	Class Tutorials on entire syllabus	: 10 marks
3.	SCILAB Tutorials	: 10 marks

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Engineering Mathematics by Srimanta Pal and SubodhBhunia, Oxford University Press
4. Applied Numerical Methods with MATLABfor Engineers and Scientists by Steven Chapra, McGraw Hill
5. Elementary Linear Algebra with Application by Howard Anton and Christ Rorres. 6th edition.
6. John Wiley & Sons,INC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC202	Engineering Physics-II	2	--	--	2	--	--	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75

Rationale:

Most of the engineering branches are being off-spring of basic sciences where physics is playing a pivotal role in concept and understanding of foundation of core engineering branches. This syllabus is developed by keeping in mind, needs of all branches that we offer in University of Mumbai.

The topic distribution is being done in systematic manner and whenever required, prerequisite to the topic are mentioned for frictionless teaching–learning process. In the distribution of topics, core physics and its applied form are given priority. At the same time few modules are introduced over emerging trends in the field of technology.

For the purpose of emphasis on applied part, list of suggestive experiments is added. As per new guidelines of AICTE, a scope is kept in the syllabus for simulation technique and use of information technology to supplement laboratory practices. Further, it is ensured that these modules will cover prerequisites needed for engineering courses to be introduced in higher semesters as core subjects or as interdisciplinary subjects in respective branches.

Objectives

1. To give exposure to the topics of fundamental physics in the area of electrodynamics and relativity.
2. To give exposure to fundamentals of physics related with current technology in the field of Nanotechnology and Physics of Sensor Technology.

Outcomes: Learners will be able to…

1. Describe the diffraction through slits and its applications.
2. Apply the foundation of laser and fiber optics in development of modern communication technology.
3. Relate the basics of electrodynamics which is prerequisite for satellite communications, antenna theory etc.
4. Explain the fundamentals of relativity.
5. Assimilate the wide scope of nanotechnology in modern developments and its role in emerging innovating applications.
6. Interpret and explore basic sensing techniques for physical measurements in modern instrumentations.

Module	Detailed Contents	Hrs.
01	**DIFFRACTION** (**Prerequisites** : Wave front and Huygen's principle, reflection and refraction, diffraction, Fresnel diffraction and Fraunhoffer diffraction)	**04**

	Diffraction: Fraunhoffer diffraction at single slit, Diffraction Grating, Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating	
02	**LASER AND FIBRE OPTICS** (**Prerequisites:** Absorption, recombination, energy bands of p-n junction, refractive index of a material, Snell's law) Laser: spontaneous emission and stimulated emission; metastable state, population inversion, types of pumping, resonant cavity, Einsteins's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography Fibre optics: Numerical Aperture for step index fibre; critical angle; angle of acceptance; V number; number of modes of propagation; types of optical fibres; Fibre optic communication system;	**06**
03	**ELECTRODYNAMICS** **(Prerequisites** : Electric Charges, Coulomb's law-force between two point charges, Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, Gauss's law, Faraday's law) Scalar and Vector field, Physical significance of gradient, curl and divergence in Cartesian co-ordinate system, Gauss's law for electrostatics, Gauss's law for magnetostatics, Faraday's Law and Ampere's circuital law; Maxwell's equations (Free space and time varying fields).	**05**
04	**RELATIVITY** **(Prerequisites**: Cartesian co-ordinate system) Special theory of Relativity: Inertial and Non-inertial Frames of reference, Galilean transformations, Lorentz transformations (space – time coordinates), Time Dilation, Length Contraction and Mass-Energy relation.	**02**
05	**NANOTECHNOLOGY** (**Prerequisites** : Scattering of electrons, Tunneling effect, Electrostatic focusing, magneto static focusing) Nanomaterials : Properties (Optical, electrical, magnetic, structural, mechanical) and applications, Surface to volume ratio; Two main approaches in nanotechnology -Bottom up technique and Top down technique; Tools for characterization of Nanoparticles: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM). Methods to synthesize Nanomaterials: Ball milling, Sputtering, Vapour deposition, Solgel	**04**
06	**PHYSICS OF SENSORS** (**Prerequisites** : Transducer concept, meaning of calibration, piezoelectric effect) Resistive sensors: a) Temperature measurement: PT100 construction, calibration, b) Humidity measurement using resistive sensors, Pressure sensor: Concept of pressure sensing by capacitive, flex and inductive method, Analog pressure sensor: construction working and calibration and applications. Piezoelectric transducers: Concept of piezoelectricity, use of piezoelectric transducer as ultrasonic generator and application of ultrasonic transducer for distance measurement, liquid and air velocity measurement. Optical sensor: Photodiode, construction and use of photodiode as ambient light measurement and flux measurement. Pyroelectric sensors: Construction and working principle, application of pyroelectric sensor as bolometer.	**05**

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Optics - Ajay Ghatak, Tata McGraw Hill
3. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
4. Concepts of Modern Physics- ArtherBeiser, Tata Mcgraw Hill
5. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
6. Introduction to Special Relativity- Robert Resnick, John Wiley and sons
7. Advances In Nano Materials And Applications: History of Nanotechnology From Pre-Historic to Modern Times, Madhuri Sharon, Wiley, USA
8. Nano: The essentials, understanding Nanoscience and Nanotechnology, T. Pradeep, Tata McGraw Hill, 2007.
9. Electronic Instrumentation –H.S. Kalsi, Tata McGraw-Hill Education
10. Handbook of Modern Sensors Physics design and application- Jacob Fraden, Springer, AIP press.
11. Instrumentation & Measurement Techniques by Albert D. Helfrick& William D. Cooper (PHI) Edition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC203	Engineering Chemistry-II	2	-	-	2	-	-	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75

Objectives

The concepts developed in this course will aid in quantification as well as understand the applications of several concepts in Chemistry that have been introduced at the 10 + 2 levels in schools.

Outcomes: Learners will be able to…

1. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
2. Illustrate the concept of emission spectroscopy and describe the phenomena of fluorescence and phosphorescence in relation to it.
3. Explain the concept of electrode potential and nernst theory and relate it to electrochemical cells.
4. Identify different types of corrosion and suggest control measures in industries.
5. Illustrate the principles of green chemistry and study environmental impact.
6. Explain the knowledge of determining the quality of fuel and quantify the oxygen required for combustion of fuel.

Module	Detailed Contents	Hrs.
01	**Principles of Spectroscopy:** Introduction: Principle of spectroscopy, Definition,Origin of spectrum, Classification of spectroscopy – atomic and molecular, selection rules. Table of relation between electromagnetic spectrum, types of spectroscopy and energy changes.	02
02	**Applications of Spectroscopy** Emission spectroscopy- Principle, Instrumentation and applications (Flame Photometry) Introduction to florescence and phosphorescence, Jablonski diagram, application of fluorescence in medicine only.	04
03	**Concept of Electrochemistry** Introduction, concept of electrode potential, Nernst equation, types of electrochemical cells, concept of standard electrode with examples, electrochemical series, simplenumericals.	02

04	**Corrosion:** Definition, Mechanism of Corrosion- (I) Dry or Chemical Corrosion-i) Due to oxygen ii)Due to other gases. (II)Wet or Electrochemical corrosion- Mechanism i) Evolution of hydrogen type ii) Absorption of oxygen. Types of Corrosion- Galvanic cell corrosion, Concentration cell corrosion (differential aeration principle), Pitting corrosion, Intergranular corrosion, Stress corrosion. Factors affecting the rate of corrosion- (i)Nature of metal, (ii)Nature of corroding environment. Methods of corrosion control- (I)Material selection and proper designing,(II) Cathodic protection- i) Sacrificial anodic protection ii) Impressed current method,(III) Metallic coatings- only Cathodic coating (tinning) and anodic coatings (Galvanising)	**06**
05	**Green Chemistry and Synthesis of drugs** Introduction – Definition, significance Twelve Principles of Green chemistry, numerical on atom economy, Conventional and green synthesis of Adipic acid, Indigo, Carbaryl, Ibuprofen, Benzimidazole, Benzyl alcohol, % atom economy and their numericals. Green fuel- Biodiesel.	**04**
06	**Fuels and Combustion** Definition, classification, characteristics of a good fuel, units of heat (no conversions). Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong's formula & numerical for calculations of Gross and Net calorific values. Solid fuels- Analysis of coal- Proximate and Ultimate Analysis- numerical problems and significance. Liquid fuels- Petrol- Knocking, Octane number, Cetane number, Antiknocking agents, unleaded petrol, oxygenates (MTBE), catalytic converter. Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.	**06**

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

Recommended Books :

1. Engineering Chemistry - Jain & Jain, DhanpatRai
2. Engineering Chemistry – Dara & Dara, S Chand
3. Green Chemistry: A textbook – V.K.Ahluwalia, Alpha Science International
4. Fundamentals of Molecular Spectroscopy (4th Edition) - C.N.Banwell, Elaine M. McCash,
   Tata McGraw Hill.
5. Elementary Organic Spectroscopy- Y.R.Sharma, S.Chand and Co.
6. A Text Book of Engineering Chemistry - ShashiChawla, DhanpatRai
7. Engineering Chemistry – Payal Joshi &Shashank Deep (Oxford University Press)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC204	Engineering Graphics	2	--	--	2	--	--	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75

Objectives

1. To impart and inculcate proper understanding of the theory of projection.
2. To impart the knowledge of reading a drawing
3. To improve the visualization skill.

Outcomes: Learners will be able to…

1. Apply the basic principles of projections in Projection of Lines and Planes
2. Apply the basic principles of projections in Projection of Solids.
3. Apply the basic principles of sectional views in Section of solids.
4. Apply the basic principles of projections in converting 3D view to 2D drawing.
5. Read a given drawing.
6. Visualize an object from the given two views.

Module	Detailed Contents	Hrs.
01	**Introduction to Engineering Graphics** Principles of Engineering Graphics and their significance, usage of Drawing instruments, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to plain and diagonal scales. **Engineering Curves** Basic construction of Cycloid, Involutes and Helix (of cylinder) only.	**2**
02	**Projection of Points and Lines** Lines inclined to both the Reference Planes (Excluding Traces of lines) and simple application based problems on Projection of lines. **@ Projection of Planes** Triangular, Square, Rectangular, Pentagonal, Hexagonal andCircular planes inclined to either HP or VP only. (Exclude composite planes).	**5**
03	**Projection of Solids** (Prism, Pyramid, Cylinder, Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method	**5**
04	**Section of Solids** Section of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to at least one reference plane (Exclude Curved Section Plane). Use change of position or Auxiliary plane method.	**5**

05	**#Orthographic and Sectional Orthographic Projections: -** Fundamentals of orthographic projections. Different views of a simple machine part as per the first angle projection methodrecommended by I.S. Full or Half Sectional views of the Simple Machine parts.	**3**
06	**#@ Missing Views:**The identification of missing views from the given views. Create the third view from the two available views so that all the details of the object are obtained.	**1**
07	**#Isometric Views:**- Principles of Isometric projection – Isometric Scale, Isometric Views, Conversion of Orthographic Views to Isometric Views(Excluding Sphere).	**3**
@ only in Term Work (i.e; Questions will not be asked for any examination.)		
# more problems should be discussed during practical hours to strengthen the concepts.		

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each.
Among the two tests One is Conventional (manual drawing) and Second using CAD software.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15marks.
2. Any 4 questions need to be solved. There won't be any compulsory Question
3. Total 04 questions need to besolved.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
4. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
5. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC205	C Programming	2	--	--	2	--	--	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC205	C Programming	15	15	15	60	2	--	--	75

Objectives

To provide exposure to problem-solving by developing an algorithm, flowchart and implement the logic using C programming language.

Outcomes: Learner will be able to…

1. Formulate simple algorithms for arithmetic, logical problems and translate them to programs in C language
2. Implement, test and execute programs comprising of control structures.
3. Decompose a problem into functions and synthesize a complete program.
4. Demonstrate the use of arrays, strings and structures in C language.
5. Understand the concept of pointers

Module	Detailed Contents	Hrs.
1	**Introduction** ● Introduction to components of a Computer System ● Introduction to Algorithm and Flowchart **Fundamentals of C Programming** ● Keywords, Identifiers, Constants and Variables ● Data types in C ● Operators in C ● Basic Input and Output Operations ● Expressions and Precedence of Operators ● In-built Functions	5
2	**Control Structures** ● Introduction to Control Structures **Branching and looping structures** ● If statement, If-else statement, Nested if-else, else-if Ladder ● Switch statement ● For loop, While loop, Do while loop ● break and continue	7
3	**Functions** ● Introduction to functions ● Function prototype, Function definition, Accessing a function and parameter passing. ● Recursion.	4

4	**Arrays and Strings** ● Introduction to Arrays ● Declaration and initialization of one dimensional and two-dimensional arrays. ● Definition and initialization of String ● String functions	**4**
5	**Structure and Union** ● Concept of Structure and Union ● Declaration and Initialization of structure and union ● Nested structures ● Array of Structures ● Passing structure to functions	**4**
6	**Pointers** ● Fundamentals of pointers ● Declaration, initialization and dereferencing of pointers ● Operations on Pointers ● Concept of dynamic memory allocation	**4**

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15marks.
2. Total 04 questions need to besolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will beasked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in thesyllabus.

Text Books:

1. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Kernighan , Ritchie, “The C programming Language”, Prentice Hall of India
3. Sumitabha Das, Computer Fundamentals and C Programming, McGraw-Hill
4. Pradeep Day and ManasGosh ,“Programming in C”, Oxford University Press.

References:

1. Byron Gottfried, “Programing with C”, McGraw Hill (Schaum‟s outline series)
2. Venugopal K.R, Prasad Sudeep, “Mastering C”, McGraw-Hill
3. KanetkarYashwant,” “Let Us C”, BPB Publication.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50

Objectives

1. To demonstrate the fundamental concepts of interpersonal and professional communication.
2. To encourage active listening with focus on content, purpose, ideas and tone.
3. To facilitate fluent speaking skills in social, academic and professional situations.
4. To train in reading strategies for comprehending academic and business correspondence.
5. To promote effective writing skills in business, technology and academic arenas.
6. To inculcate confident personality traits along with grooming and social etiquettes.

Outcomes: Learners will be able to understand how to…

1. Eliminate barriers and use verbal/non-verbal cues at social and workplace situations.
2. Employ listening strategies to comprehend wide-ranging vocabulary, grammatical structures, tone and pronunciation.
3. Prepare effectively for speaking at social, academic and business situations.
4. Use reading strategies for faster comprehension, summarization and evaluation of texts.
5. Acquire effective writing skills for drafting academic, business and technical documents.
6. Successfully interact in all kinds of settings, displaying refined grooming and social skills.

Module	Detailed Contents	Hrs.
1	**FUNDAMENTALS OF COMMUNICATION** **1.1. Introduction to Theory of Communication** ● Definition ● Objectives ● Postulates/Hallmarks ● The Process of Communication ● Organizational Communication ○ Formal (Upward, Downward and Horizontal) ○ Informal (Grapevine) **1.2. Methods of Communication** ● Verbal (Written & Spoken) ● Non-verbal ○ Non-verbal cues perceived through the five senses: (Visual, Auditory, Tactile, Olfactory and Gustatory cues) ○ Non-verbal cues transmitted through the use of: (The Body, Voice, Space, Time and Silence) **1.3. Barriers to Communication** ● Mechanical/External	**12**

	● Physical/Internal ● Semantic & Linguistic ● Psychological ● Socio-Cultural **1.4. Communication at the Workplace** ● Corporate Communication - Case Studies ● Listening Tasks with Recordings and Activity Sheets ● Short Speeches as Monologues ○ Informative Speeches that Center on People, Events, Processes, Places, or Things ○ Persuasive Speeches to Persuade, Motivate or Take Action ○ Special Occasion Speeches for Ceremonial, Commemorative, or Epideictic purposes ● Pair-work Conversational Activities (Dialogues) ● Short Group Presentations on Business Plans	
2	**VERBAL APTITUDE FOR EMPLOYMENT** **2.1. Vocabulary Building** ● Root words (Etymology) ● Meaning of Words in Context ● Synonyms & Antonyms ● Collocations ● Word Form Charts ● Prefixes & Suffixes ● Standard Abbreviations **2.2. Grammar** ● Identifying Common Errors ○ Subject - Verb Agreement ○ Misplaced Modifiers ○ Articles ○ Prepositions ● Tautologies ● Pleonasms (Redundancies) ● Idioms ● Cliches	**02**
3	**DEVELOPING READING AND WRITING SKILLS** **3.1. Reading Comprehension** ● Long Passages ● Short Passages ● MCQs on Inferential Questions with 4 Options **3.2. Summarization of reading passages, reports, chapters, books** ● Graphic Organizers for Summaries ○ Radial Diagrams like Mind Maps ○ Flow Charts ○ Tree Diagrams ○ Cyclic Diagrams ○ Linear Diagrams like Timelines ○ Pyramids ○ Venn Diagrams ● Point-form Summaries ● One-sentence Summaries of Central Idea **3.3. Paraphrasing** ● Understanding Copyrights ● Running a Plagiarism Check on Paraphrased Passages ● Generating Plagiarism Reports	**02**

	● Basic APA and MLA Referencing Style and Format	
4	**BUSINESS CORRESPONDENCE** **4.1. Seven Cs of Business Correspondence** ● Completeness ● Conciseness ● Consideration ● Concreteness ● Clarity ● Courtesy ● Correctness **4.2. Parts of a Formal Letter and Formats** ● Parts/Elements of a Formal Letter ○ Letterheads and/or Sender's Address ○ Dateline ○ Inside Address ○ Reference Line (Optional) ○ Attention Line (Optional) ○ Salutation ○ Subject Line ○ Body ○ Complimentary Close ○ Signature Block ○ Enclosures/Attachments ● Complete/Full Block Format **4.3. Emails** ● Format of Emails ● Features of Effective Emails ● Language and style of Emails **4.4. Types of Letters in Both Formal Letter Format and Emails** ● Claim & Adjustment Letters ● Request/Permission Letters ● Sales Letters	**06**
5	**BASIC TECHNICAL WRITING** **5.1. Introduction** ● What is Technical Writing? ● Importance and Principles of Technical Writing ● Difference between Technical Writing & Literary Writing ● Framing Definitions ● Difference between Technical Description & Instructions **5.2. Description of a Technical Object** ● Definition ● Diagram ● Discussion of Parts/Characteristics Working **5.3. Writing User Instructions** ● User Instructions ● Special Notices (Note, Warning, Caution and Danger) ● Styles of Presentation ○ Impersonal ○ Indirect ○ Direct ● Imperative **5.4. Description of a Technical / Scientific Process**	**02**

	● Definition ● Diagram ● Tools/ Apparatus/Software/ Hardware Used ● Working ● Result	
6	**PERSONALITY DEVELOPMENT AND SOCIAL ETIQUETTES** **6.1. Personality Development** ● Introducing Self and/or a Classmate ● Formal Dress Code **6.2. Social Etiquettes** ● Formal Dining Etiquettes ● Cubicle Etiquettes ● Responsibility in Using Social Media ● Showing Empathy and Respect ● Learning Accountability and Accepting Criticism ● Demonstrating Flexibility and Cooperation ● Selecting Effective Communication Channels	**02**

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 10 marks each.

TEST I -Public speech on general topics (Maximum 5 mins. per student)

TEST II - Written test covering modules 1 - 6
The second test should be based on theory and application exercises as mentioned in the syllabus. (Note: Summarization should be a compulsory question in Test II and not in the End Semester Theory Examination.)

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus
6. The first module (Fundamentals of Communication) will carry 40 % weightage.

Text Books.

1. Sanjay Kumar & Pushp Lata (2018). Communication Skills with CD. New Delhi: Oxford University Press.
2. Hemphill, P.D., McCormick, D. W., & Hemphill, R. D. (2001). Business Communication with writing improvement exercises. Upper Saddle River, NJ: Prentice Hall.
3. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication: Building Critical Skills. Place of publication not identified: Mcgraw-hill.
4. Murphy, H. (1999). Effective Business Communication. Place of publication not identified: Mcgraw-Hill.
5. Raman, M., & Sharma, S. (2016). Technical Communication: Principles and practice. New Delhi: Oxford University Press.

6. Kaul, A. (2015). Effective Business Communication. Place of publication not identified: Prentice-Hall of India.
7. Rizvi, A. M. (2010). Effective Technical Communication: A guide for Scientists and Engineers. New Delhi: Tata McGraw Hill.
8. Lewis, N. (2014). Word power made easy. Random House USA.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL201	Engineering Physics-II	-	01	-	-	-	0.5	0.5

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25

Objectives

1. To improve the knowledge about the theory learned in the class.
2. To improve ability to analyze experimental result and write laboratory report.

Outcomes: Learners will be able to…

1. Perform the experiments based on diffraction through slitsusing Laser source and analyze the results.
2. Perform the experiments using optical fibre to measure numerical aperture of a given fibre.
3. Perform the experiments on various sensors and analyze the result.

Suggested Experiments:(Any five)

1. Determination of wavelength using Diffraction grating. (Hg/Na source)
2. Determination of number of lines on the grating surface using LASER Source.
3. Determination of Numerical Aperture of an optical fibre.
4. Determination of wavelength using Diffraction grating.(Laser source)
5. Study of divergence of laser beam
6. Determination of width of a slit using single slit diffraction experiment(laser source)
7. Study of I-V characteristics of Photo diode.
8. Study of ultrasonic distance meter/ interferometer.
9. Study of PT100 calibration and use and thermometer
10. Study of J /K type thermocouple, calibration and use and thermometer
11. Simulation experiments based on nanotechnology using open source simulation softwares like Avogadro, Chimera, JMOL etc.

Term work:

Term Work shall consist of minimum five experiments.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) **: 10 marks**
- Project Groupwise (Execution & Submission) **: 10 marks**
- Attendance (Theory and Tutorial) **: 05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL202	Engineering Chemistry-II	-	01	-	-	-	0.5	0.5

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25

Outcomes: Learner will be able to…

1. Determine moisture and ash content of coal
2. Analyze flue gas
3. Determine saponification and acid value of oil
4. Determine flash point of a lubricating oil
5. Synthesize a drug and a biofuel.
6. Determine na/k and emf of cu-zn system

Suggested Experiments

1. Determination of Moisture content of coal.
2. Determination of Ash content of coal.
3. Flue gas analysis using Orsat's apparatus.
4. Saponification value of oil
5. Acid value of oil
6. Determination of Na/K by Flame photometry.
7. Preparation of Biodiesel from edible oil.
8. To estimate the emf of Cu-Zn system by Potentiometry.
9. Synthesis of Aspirin.
10. Determination of Flash point of a lubricant using Abel's apparatus

Term work:

Term Work shall consist of minimum five experiments.
The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) **:** **10 marks**
- Assignments and Viva on practicals **:** **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL203	Engineering Graphics	-	04	-	-	-	2	2

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75

Objectives

1. To inculcate the skill of drawing with the basic concepts.
2. To Use AutoCAD for daily working process.
3. To teach basic utility of Computer Aided drafting (CAD) tool

Outcomes: Learner will be able to…

1. Apply the basic principles of projections in 2D drawings using a CAD software.
2. Create, Annotate, Edit and Plot drawings using basic AutoCAD commands and features.
3. Apply the concepts of layers to create drawing.
4. Apply basic AutoCAD skills to draw different views of a 3D object.
5. Apply basic AutoCAD skills to draw the isometric view from the given two views.

Component-1 (Use half Imperial Drawing Sheet)

	Activities to be completed in the Drawing Laboratory.	**Hrs**
	One Practice sheet on projection of solids(minimum 2 problems)	4
	# Term Sheet 1: Projection of Solids (3 Problems).	4
	One Practice sheet on Section of Solids. (minimum 2 problems) # Term Sheet 2: Section of solids. (3 problems).	6
	One practice sheet on Orthographic projection. (minimum 1 problem) # Term Sheet 3: Orthographic Projection (With section 1 problem, without section 1 problem).	6
	One practice sheet on Isometric drawing. (minimum 2 problems) # Term Sheet 4: Isometric Projection. (3 problems).	4
# Term sheets to be done in laboratory only and to be **submitted as part of term work**. *Note: Practice sheets to be done before starting the Term Sheets.*		

Component-2

Self-study problems/ Assignment: (In A3 size Sketch book, to be submitted as part of Term Work)

1. Engineering Curves. (2 problems)
2. Projection of Lines (2 problems)
3. Projection of planes (2 problems)
4. Projection of solids. (2 problems)
5. Section of solids (2 problems)
6. Orthographic Projection. (With section 1 problem, without section 1 problem).
7. Missing views. (1 problem)
8. Isometric Drawing. (2 problems)

Computer Graphics: Engineering Graphics Software - Orthographic Projections, Isometric Projections, Co-ordinate Systems, Multi-view Projection.		
Part-A	**To be Taught in laboratory.**	**Hrs**
	Overview of Computer Graphics Covering: Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.	**3**
	Customization & CAD Drawing: Consisting of set up of the drawing page and the printer including scale settings, Setting up of units and drawing limits, ISO and ANSI standards for coordinate dimensioning.	**3**
	Annotations, layering & other Functions Covering: Applying dimensions to objects, applying annotations to drawings, Setting up and use of layers, layers to create drawings, Create, edit and use customized layers, Changing line lengths through modifying existing lines (extend/lengthen), Printing documents to paper using the print command, orthographic projection techniques, Drawing sectional views of objects (simple machine parts).	**4**
Part-B	*** Activities to be completed in the CAD Laboratory. (All printouts to be the part of Term Work. Preferably, Use A3 size sheets for print out.)** **Component-3**	
	1. Orthographic Projections (without section)- 1 problem	**4**
	2. Orthographic Projection (with section)- 1 problem	**4**
	3. Orthographic Reading – 1 problem	**2**
	4. Isometric Drawing – 3 problem.	**4**

Note: * Give practice sheet problems before going for Term Sheet problems.
Students are supposed to bring complete solution of problems before coming to CAD practical.

Term Work:

Component-1	:	7Marks
Component-2	:	6 Marks
Component-3	:	7 Marks
Attendance	:	5 Marks
Total Marks	**:**	**25 Marks**

Note: Satisfactory submission of all 3 components is mandatory to full fill the Term.

Topic for the End Semester Practical Examination (Auto CAD) (2 hours/ 50 Marks.)

1. Isometric drawing. (1 problem) (20 Marks)
2. Orthographic Projection (With Section) (1 problem). (30 Marks)

Note:

1. **Printout of the answers have to be taken preferably in A3 size sheets and should be Assessed by External Examiner only.**
2. **Knowledge of Auto CAD software, concepts of Engineering Graphics related to specified problem and accuracy of drawing should be considered during evaluation**.

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
2. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
3. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL204	C programming	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
FEL204	C programming	--	--	--	--	--	25	25	50

Outcomes: Learner will be able to…

1. Translate given algorithms to a program.
2. Correct syntax and logical errors.
3. Write iterative as well as recursive programs.
4. Represent data in arrays, strings and structures and manipulate them through a program.
5. Declare pointers and demonstrate call by reference concept.

Lab Description:

Weekly 2 hours of laboratory Programming Assignments on the following topics:

1. Basic data types and I/O operations
2. Branching Statements
3. Loop Statements
4. Arrays
5. Strings
6. Functions
7. Recursion
8. Structure and Union
9. Pointers

Term Work:

Experiments (20 Programs) and Assignments (2 Assignments) should be completed by students on the given time duration

Experiments:	15 Marks
Assignment:	05 Marks
Attendance:	05 Marks
Total:	**25 Marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Computer Programming in C subject for given list of experiments.

Implementation:	15 Marks
Oral:	10 Marks
Total:	**25 Marks**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL205	Professional Communication and Ethics- I	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25

Objectives

To provide practice in ...

1. Active listening with focus on content, purpose, main idea, tone and pronunciation.
2. Fluent speaking and presentation skills in social, academic and professional situations.
3. Faster reading skills for effective comprehension in a variety of texts.
4. Drafting effective written discourse in academics, business and technology.
5. Grooming and projecting impressive persona in all interactions.

Outcomes: Learner will be able to…

1. Listen and comprehend all types of spoken discourse successfully.
2. Speak fluently and make effective professional presentations.
3. Read large quantities of text in a short time to comprehend, summarise and evaluate content.
4. Draft precise business letters, academic essays and technical guidelines.
5. Dress finely and conduct themselves with panache in social, academic and professional situations.

List of Assignments & Activities	Details of Assignments	Details of Activities	Hrs.
1.	Written record of listening activities	Listening practice tasks of 3 types (through audio recordings of (1) Monologues (2) Dialogues (3) Formal/Expert Talk or Lecture)	**02**
2.	Transcription of the public speech along with a plagiarism report	Practice public speech	**02**
3.	Transcription of the public speech along with a plagiarism report	Public speech (Internal Assessment - I)	**02**
4.	Written assignment on barriers and non-verbal communication	Role plays / case studies	**02**
5.	Summarization through graphic organisers (1. Text to graphic	NA	**02**

	organizer 2. Graphic organizer to text)		
6.	Written record of reading activities	Advanced level reading comprehension with MCQs (similar in level and format to CAT, GRE and GMAT verbal sections)	**02**
7.	Aptitude test on vocabulary and grammar	Aptitude test on vocabulary and grammar (similar in level and format to CAT, GRE and GMAT verbal sections)	**02**
8.	2 types of letters in complete block format	NA	**02**
9.	Written assignment on technical writing (Exercises based on framing Definitions, Describing Technical Objects, Framing User Instructions and Describing Technical Processes)	NA	**02**
10.	Documentation on case studies / role plays on Module 6	Case studies / role plays	**02**

Assessment:

The distribution of marks for term work shall be as follows:

- Assignments **: 20 marks**
- Attendance (Theory and Practical) **: 05 marks**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEL206	Basic Workshop Practice-II	--	2	--	--	--	1	1

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL206	Basic Workshop Practice-II	--	--	--	--	--	50	--	50

Objectives

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Outcomes: Learner will be able to…

1. Develop the necessary skill required to handle/use different carpentry tools.
2. Identify and understand the safe practices to adopt in electrical environment.
3. Demonstrate the wiring practices for the connection of simple electrical load/ equipment.
4. Design, fabricate and assemble pcb.
5. Develop the necessary skill required to handle/use different masons tools.
6. Develop the necessary skill required to use different sheet metal and brazing tools.
7. Able to demonstrate the operation, forging with the help of a simple job.

	Detailed Content	**Hrs.**
Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work CO-1 is related to Trade-1 CO-2 to CO-4 is related to Trade-2 CO-5 is related to Trade-3 CO-6 is related to Trade-4 CO-7 is related to Trade-5 CO evaluation is to be done according to the opted Trades in addition to Compulsory Trades.		
Trade-1	**Carpentry(Compulsory)** 6. Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood tuning and modern wood turning methods. **7.** Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning	**10**

Trade-2	**Basic Electrical work shop:(Compulsory):** 8. Single phase and three phase wiring. Familiarization. of protection switchgears and their ratings (fuse, MCB, ELCB). Wiring standards, Electrical safety in the work place safe work practices. Protective equipment, measures and tools. 9. Layout drawing, layout transfer to PCB, etching and drilling and soldering technique	**08**
Trade-3	**Masonry:** **10.** Use of masons tools like trowels, hammer, spirit level, square, plumb line and pins etc. demonstration of mortar making, single and one and half brick masonry , English and Flemish bonds, block masonry, pointing and plastering.	**06**
Trade 4	**Sheet metal working and Brazing:** 11. Use of sheet metal, working hand tools, cutting , bending , spot welding	**06**
Trade-5	**Forging (Smithy):** 12. At least one forging job to be demonstrated and a simple job to be made for Term Work in a group of 4 students.	**06**

AC: **23/7/2020**

Item No. : **126**

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 23/7/2020
Item No. 126

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Information Technology Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date :23/7/2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
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Dr. Anuradha Muzumdar
Dean
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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface By BoS

It is our honor and a privilege to present the Rev-2019 'C' scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology Engineering - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)
Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ITC302	Data Structure and Analysis	3		--	3		--	3
ITC303	Database Management System	3	--	--	3	--	--	3
ITC304	Principle of Communication	3	--	--	3	--	--	3
ITC305	Paradigms and Computer Programming Fundamentals	3	--	--	3	--	--	3
ITL301	Data Structure Lab	--	2	--	--	1	--	1
ITL302	SQL Lab	--	2	--	--	1	--	1
ITL303	Computer programming Paradigms Lab	--	2	--	--	1	--	1
ITL304	Java Lab (SBL)	--	4	--	--	2	--	2
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test2**	**Avg.**					
ITC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ITC302	Data Structure and Analysis	20	20	20	80	3	--	--	100
ITC303	Database Management System	20	20	20	80	3	--	--	100
ITC304	Principle of Communication	20	20	20	80	3	--	--	100
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	3	--	--	100
ITL301	Data Structure Lab	--	--	--	--	--	25	25	50
ITL302	SQL Lab	--	--	--	--	--	25	25	50
ITL303	Computer programming Paradigms Lab	--	--	--	--	--	25	25	50
ITL304	Java Lab (SBL)	--	--	--	--	--	25	25	50
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups.

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC301	Engineering Mathematics-III	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC301	Engineering Mathematics-III	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2	To acquaint with the concept of Fourier series, its complex form and enhance the problem solving skills.
3	To familiarize the concept of complex variables, C-R equations with applications.
4	The fundamental knowledge of Trees, Graphs etc.
5	To study the basic techniques of statistics like correlation, regression and curve fitting for data analysis, Machine learning and AI.
6	To understand some advanced topics of probability, random variables with their distributions and expectations.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply the concept of Laplace transform to solve the real integrals in engineering problems.	L1, L2
2	Apply the concept of inverse Laplace transform of various functions in engineering problems.	L1, L2

3	Expand the periodic function by using Fourier series for real life problems and complex engineering problems.	L1, L2, L3
4	Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.	L1, L2, L3
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.	L2, L3
6	Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.	L1, L2

Module	**Detailed Contents**	**Hours**	**CO Mapping**
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of real integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	7	CO1
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives, 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations	6	CO1, CO2
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity(without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	7	CO3

04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	7	CO4
05	**Module: Statistical Techniques** 5.1 Karl Pearson's Coefficient of correlation (r) 5.2 Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks) 5.3 Lines of regression 5.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6	CO5
06	**Module: Probability** 6.1 Definition and basics of probability, conditional probability, 6.2 Total Probability Theorem and Baye's theorem 6.3 Discrete and continuous random variable with probability distribution and probability density function. 6.4 Expectation of random variables with mean, variance and standard deviation, moment generating function up to four moments. **Self-learning Topics:** Skewness and Kurtosis of distribution (data)	6	CO6

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
5. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
6. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC302	Data Structure and Analysis	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC302	Data Structure and Analysis	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The fundamental knowledge of data structures.
2	The programming knowledge which can be applied to sophisticated data structures.
3	The fundamental knowledge of stacks queue, linked list etc.
4	The fundamental knowledge of Trees, Graphs etc.
5	The fundamental knowledge of different sorting, searching, hashing and recursion techniques
6	The real time applications for stacks, queue, linked list, trees, graphs etc.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Classify and Apply the concepts of stacks, queues and linked list in real life problem solving.	L1, L2, L3
2	Classify, apply and analyze the concepts trees in real life problem solving.	L2, L3,L4
3	Illustrate and justify the concepts of graphs in real life problem solving.	L3, L5
4	List and examine the concepts of sorting, searching techniques in real life problem solving.	L2, L3, L4
5	Use and identify the concepts of recursion, hashing in real life problem solving.	L3, L4
6	Examine and justify different methods of stacks, queues, linked list, trees and graphs to various applications.	L3, L4, L5

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Defining, Declaring and Initialization of structure variables. Accessing members of a structure, Array of structures, Nested structures, Pointers to structures. Passing structure, structure members, structure arrays and pointer to structure as function parameters. Self-referential structures.	**02**	---
I	Introduction to Stacks, Queues and Linked Lists	Introduction to Data Structures: Linear and Non Linear Data Structures, Static and Dynamic Data Structures. Concept of Stack and Queue. Array Implementation of Stack and Queue, Circular Queue, Double Ended Queue, Priority Queue. Concept of Linked Lists. Singly linked lists, doubly linked lists and circular linked lists. Insertion, deletion, update and copying operations with Singly linked lists, doubly linked lists and circular linked lists. Reversing a singly linked list. **Self-learning Topics:** Linked List Implementation of Stack, Linked List implementation of Queue, Circular Queue, Double Ended Queue, Priority Queue.	**08**	CO1
II	Trees	Introduction to Trees: Terminology, Types of Binary trees. Non recursive Preorder, in-order and post-order traversal. Creation of binary trees from the traversal of binary trees. Binary search tree: Traversal, searching, insertion and deletion in binary search tree. Threaded Binary Tree: Finding in-order successor and predecessor of a node in threaded tree. Insertion and deletion in threaded binary tree. AVL Tree: Searching and traversing in AVL trees. Tree Rotations: Right Rotation, Left Rotation. Insertion and Deletion in an AVL Tree. B-tree: Searching, Insertion, Deletion from leaf node and non-leaf node. B+ Tree, Digital Search Tree, Game Tree & Decision Tree **Self-learning Topics:** Implementation of AVL and B+ Tree	**07**	CO1, CO 2
III	Graphs	Introduction to Graphs: Undirected Graph, Directed Graph, graph terminology, Connectivity in Undirected and Directed Graphs. Spanning tree. Representation of graph: adjacency matrix, adjacency list, Transitive closure of a directed graph and path matrix.	**05**	CO1, CO3

		Traversals: Breadth First Search, Depth First Search. **Self-learning Topics:** Implementation of BFS, DFS		
IV	Recursion and Storage Management	Recursion: Writing a recursive function, Flow of control in recursive functions, Winding and unwinding phase, Recursive data structures, Implementation of recursion. Tail recursion. Indirect and Direct Recursion. Storage Management: Sequential Fit Methods: First Fit, Best Fit and Worst Fit methods. Fragmentation, Freeing Memory, Boundary Tag Method. Buddy Systems: Binary Buddy System, Fibonacci Buddy System. Compaction, Garbage Collection. **Self-learning Topics:** Implementation of recursion function.	**06**	CO5
V	Searching and Sorting	Searching: Sequential Search, Binary Search. Hashing: Hash Functions: Truncation, Mid-square Method, Folding Method, Division Method. Collision Resolution: Open Addressing: Linear Probing, Quadratic Probing, Double Hashing, Separate Chaining Bucket Hashing. Analysis of all searching techniques Sorting: Insertion sort, Selection sort, Merge sort, Quick sort and Radix sort. Analysis of all sorting techniques **Self-learning Topics:** Implementation of different sorting techniques and searching.	**05**	CO 4, CO5
VI	Applications of Data Structures	Applications of Linked Lists: Addition of 2 Polynomials and Multiplication of 2 polynomials. Applications of Stacks: Reversal of a String, Checking validity of an expression containing nested parenthesis, Function calls, Polish Notation: Introduction to infix, prefix and postfix expressions and their evaluation and conversions. Application of Queues: Scheduling, Round Robin Scheduling Applications of Trees: Huffman Tree and Heap Sort. Applications of Graphs: Dijkstra's Algorithm, Minimum Spanning Tree: Prim's Algorithm, Kruskal's Algorithm. **Self-learning Topics:** Implementation of applications for Stack, Queues, Linked List, Trees and Graph.	**06**	CO6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Online References:

Sr. No.	Website Name
2.	https://www.nptel.ac.in
3.	https://opendatastructures.org/
3.	https://www.coursera.org/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC303	Database Management System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC303	Database Management System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the basics and understand the need of database management system.
2	To construct conceptual data model for real world applications
3	To Build Relational Model from ER/EER.
4	To introduce the concept of SQL to store and retrieve data efficiently.
5	To demonstrate notions of normalization for database design.
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the need of Database Management System.	L1, L2
2	Design conceptual model for real life applications.	L6
3	Create Relational Model for real life applications	L6
4	Formulate query using SQL commands.	L3
5	Apply the concept of normalization to relational database design.	L3
6	Demonstrate the concept of transaction, concurrency and recovery.	L2

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Comment**Basic knowledge of operating systems and file systems, Any programming	**02**	--
I	**Database System Concepts and Architecture**	Introduction, Characteristics of Databases, File system v/s Database system, Data abstraction and Data Independence, DBMS system architecture, Database Administrator (DBA), Role of DBA **Self-learning Topics:** Identify the types of Databases.	**05**	CO1
II	**The Entity-Relationship Model**	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Weak entity Types Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model. **Self-learning Topics:** Design an ER model for any real time case study.	**05**	CO2
III	**Relational Model & Relational Algebra**	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for Unary Relational Operations, • Set Theory operations, • Binary Relational operation Relational Algebra Queries **Self-learning Topics:** Map the ER model designed in module II to relational schema..	**05**	CO3
IV	**Structured Query Language (SQL) & Indexing**	Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, nested Queries ; Integrity constraints in SQL. Database Programming with JDBC, Security and authorization: Grant & Revoke in SQL Functions and Procedures in SQL and cursors. Indexing:Basic Concepts, Ordered Indices, Index Definition in SQL **Self-learning Topics:** Physical design of database for the relational model designed in module III and fire various queries.	**08**	CO4

V	**Relational Database Design**	Design guidelines for relational Schema, Functional Dependencies, Database tables and normalization, The need for normalization, The normalization process, Improving the design, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF). **Self-learning Topics:** Consider any real time application and normalization upto 3NF/BCNF	**07**	CO5
VI	**Transactions Management and Concurrency and Recovery**	Transaction: Transaction concept, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling Timestamp-based protocols, Recovery System: Recovery Concepts, Log based recovery. **Self-learning Topics:** Study the various deadlock situation which may occur for a database designed in module V.	**07**	CO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ―Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
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3.	https://www.coursera.org/

Assessment:

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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC304	Principle of Communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC304	Principle of Communication	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Study the basic of Analog and Digital Communication Systems.
2	Describe the concept of Noise and Fourier Transform for analyzing communication systems.
3	Acquire the knowledge of different modulation techniques such as AM, FM and study the block diagram of transmitter and receiver.
4	Study the Sampling theorem and Pulse Analog and digital modulation techniques
5	Learn the concept of multiplexing and digital band pass modulation techniques
6	Gain the core idea of electromagnetic radiation and propagation of waves.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe analog and digital communication systems	L1,L2
2	Differentiate types of noise, analyses the Fourier transform of time and frequency domain.	L1, L2, L3, L4
3	Design transmitter and receiver of AM, DSB, SSB and FM.	L1,L2,L3,L4
4	Describe Sampling theorem and pulse modulation systems.	L1,L2,L3
5	Explain multiplexing and digital band pass modulation techniques.	L1, L2
6	Describe electromagnetic radiation and propagation of waves.	L1,L2

Prerequisite: Basic of electrical engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Terminologies in communication systems, analog and digital electronics	**02**	
I	**Introduction**	Basics of analog communication and digital communication systems (Block diagram), Electromagnetic Spectrum and application, Types of Communication channels. **Self-learning Topics:** Applications areas of analog and digital communication.	**03**	**CO1**
II	**Noise and Fourier Representation of Signal and System**	Basics of signal representation and analyses, Introduction to Fourier Transform, its properties (time and frequency shifting, Fourier transform of unit step, delta and gate function. Types of Noise, Noise parameters –Signal to noise ratio, Noise factor, Noise figure, Friss formula and Equivalent noise temperature. **Self-learning Topics:** Practice Numerical on above topic.	**06**	**CO2**
III	**Amplitude and Angle modulation Techniques.**	Need for modulation, Amplitude Modulation Techniques: DSBFC AM,DSBSC-AM, SSB SC AM- block diagram spectrum, waveforms, bandwidth, Power calculations. Generation of AM using Diode, generation of DSB using Balanced modulator, Generation of SSB using Phase Shift Method. AM Transmitter (Block Diagram) AM Receivers – Block diagram of TRF receivers and Super heterodyne receiver and its characteristics- Sensitivity, Selectivity, Fidelity, Image frequency and its rejection and double spotting **Angle Modulation** **FM:** Principle of FM- waveforms, spectrum, bandwidth. Pre- emphasis and de-emphasis in FM, FM generation: Direct method –Varactor diode Modulator, Indirect method (Armstrong method) block diagram and waveforms. FM demodulator: Foster Seeley discriminator, Ratio detector. **Self-learning Topics:** Use of AM and FM in Modern Communication Technology. Challenges faced by radio business.	**12**	**CO1, CO2, CO3**
IV	**Pulse Analog Modulation and Digital Modulation**	Sampling theorem for low pass and band pass signals with proof, Anti- aliasing filter, PAM, PWM and PPM generation and Degeneration. Quantization process, Pulse code modulation, Delta modulation, Adaptive delta modulation. Introduction to Line Codes and ISI.	**08**	**CO1, CO2, CO4**

		Self-learning Topics: Implementation of Pulse code modulation and demodulation.		
V	**Multiplexing and Digital Band Pass Modulation Techniques**	Principle of Time Division Multiplexing, Frequency Division Multiplexing , Orthogonal Frequency Division Multiplexing and its applications .ASK, FSK, PSK QPSK Generation and detection. **Self-learning Topics:** Implement TDM, FDM, OFDM.	**04**	**CO1, CO2, CO5**
VI	**Radiation and Propagation of Waves**	Electromagnetic radiation, fundamentals, types of propagation, ground wave, sky wave, space wave tropospheric scatter propagation **Self-learning Topics:** List the real time examples for different types of propagation waves.	**04**	**CO6**

Text Books:

[1]. George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed
[2]. Simon Haykin, Michael Moher, Introduction to Analog & Digital Communications, Wiley India Pvt. Ltd., 2nd Ed.
[3].Wireless Communication and Networking, Vijay Garg

References:

[1]. Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.
[2]. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University
[3]. Herbert Taub, Donald L Schilling, Goutam Saha, Principles of Communication Systems, Tata McGraw Hill, 3rdEd.
[4]. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.classcentral.com
3.	http://www.vlab.co.in/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC305	Paradigms and Computer Programming Fundamentals	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce various programming paradigms and the basic constructs that underline any programming language.
2	To understand data abstraction and object orientation
3	To introduce the basic concepts of declarative programming paradigms through functional and logic programming.
4	To design solutions using declarative programming paradigms through functional and logic programming.
5	To introduce the concepts of concurrent program execution.
6	To understand use of scripting language for different problem domains

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and Compare different programming paradigms.	L1, L2
2	Understand the Object Oriented Constructs and use them in program design.	L1, L2
3	Understand the concepts of declarative programming paradigms through functional and logic programming.	L1, L2
4	Design and Develop programs based on declarative programming paradigm using functional and/or logic programming.	L5, L6
5	Understand the role of concurrency in parallel and distributed programming.	L1, L2
6	Understand different application domains for use of scripting languages.	L1. L2

Prerequisite: Students must have learned C Programming (FEC205 and FEL204),

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Compilation and interpretation Focus on overview of compilation steps.	**02**	CO1
I	Introduction to Programming Paradigms and Core Language Design Issues	Introduction to different programming paradigms. Names, Scopes, and Bindings, Scope Rules, Storage Management. Type Systems, Type Checking, Equality Testing and Assignment. Subroutine and Control Abstraction: Stack Layout, Calling sequence, parameter passing Generic subroutines and modules. Exception handling, Coroutines and Events. **Self-Learning Topic:** Implementation of basic concepts using programming language.	**10**	CO1
II	Imperative Paradigm: Data Abstraction in Object Orientation	Grouping of data and Operations- Encapsulation, Overloading, Polymorphism, Inheritance, Initialization and Finalization, Dynamic Binding. **Self-Learning Topic:** Implementation of OOP concepts using preferrably C++ and Java language.	**05**	CO2
III	Declarative Programming Paradigm: Functional Programming	Introduction to Lambda Calculus, Functional Programming Concepts, Evaluation order, Higher order functions, I/O-Streams and Monads. **Self-Learning Topic:** Implementation of programs using functional programming Language Haskel can refer to hacker rank website for problem statements.	**07**	CO3, CO4
IV	Declarative Programming Paradigm: Logic Programming	Logic Programming with PROLOG - Resolution and Unification, Lists, Arithmetic execution order, imperative control flow, database manipulation, PROLOG facilities and deficiencies. **Self-Learning Topic:** Identification of different application domains for use of Prolog and Logic programming	**06**	CO3, CO4
V	Alternative Paradigms: Concurrency	Concurrent Programming Fundamentals, Implementing synchronisation, Message Passing - Background and Motivation, Multithreaded programs, Communication and Synchronization, Language and Libraries, Thread creation Syntax. **Self-Learning Topic:** Study Implementation of concurrency concepts for real time application.	**04**	CO5
VI	Alternative Paradigms: Scripting Languages	Common characteristics, Different Problem domains for using scripting,Use of scripting in Web development–server and clients side scripting, Innovative features of scripting languages - Names and Scopes, string and pattern manipulation, data types, object orientation.	**05**	CO6

		Self-Learning Topic: Review small client server application code in any scripting language to realise applicability of features learned in Module.		

Text Books:

1. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
2. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016
3. Programming Languages: Concepts and Constructs; 2nd Edition, Ravi Sethi, Pearson Education Asia, 1996.

References:

1. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition) (February 2, 2016)
2. Programming Languages: Design and Implementation (4th Edition), by Terrence W. Pratt, Marvin V. Zelkowitz, Pearson, 2000
3. Rajkumar Buyya, Object-oriented Programming with Java: Essentials and Applications, Tata McGraw Hill Education Private Limited
4. Max Bramer, Logic Programming with Prolog, Springer ISBN-13: 978-1852-33938-8

Online References:

Sr No	Website Name	Link
1	Principles of programming Languages (Videos)	https://nptel.ac.in/courses/106/102/106102067/
2	Edx course Paradigms of Computer Programming – Fundamentals	https://www.classcentral.com/course/edx-paradigms-of-computer-programming-fundamentals-2298
3	Udemy Couses	https://www.udemy.com

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

► Question paper format

- Question Paper will comprise of a total of six questions each carrying 20 marks Q.1 will be compulsory and should cover maximum contents of the syllabus.
- Remaining questions will be mixed in nature (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of four questions need to be answered

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL301	Data Structure Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL301	Data Structure Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To use data structures as the introductory foundation for computer automation to engineering problems.
2	To use the basic principles of programming as applied to complex data structures.
3	To learn the principles of stack, queue, linked lists and its various operations.
4	To learn fundamentals of binary search tree, implementation and use of advanced tree like AVL, B trees and graphs.
5	To learn about searching, hashing and sorting.
6	To learn the applications of linked lists, stacks, queues, trees and graphs.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and use the basic concepts and principles of various linked lists, stacks and queues.	L1, L2, L3
2	Understand the concepts and apply the methods in basic trees.	L1, L2
3	Use and identify the methods in advanced trees.	L3, L4
4	Understand the concepts and apply the methods in graphs.	L2, L3
5	Understand the concepts and apply the techniques of searching, hashing and sorting	L2, L3
6	Illustrate and examine the methods of linked lists, stacks, queues, trees and graphs to various real time problems	L3, L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Turbo/Borland C complier

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction of C programming language.	**02**	----
I	Stacks, Queues and Linked Lists	• Array Implementation of Stack and Queue. • Insertion, deletion operations with Singly linked lists • Insertion, deletion operations Doubly linked lists • Insertion, deletion operations Circular linked lists. • Reversing a singly linked list. • *** Linked List implementation of Stack and Queue**	**04**	LO 1
II	Trees	• *** Implementation of operations (insertion, deletion, counting of nodes, counting of leaf nodes etc.) in a binary search tree.** • Implementation of insertion, deletion and traversal for fully in-threaded binary search tree.	**04**	LO 2
III	Advanced Trees	• *** Implementation of AVL tree.** • Implementation of operations in a B tree.	**04**	LO 3
IV	Graphs	• Implementation of adjacency matrix creation. • Implementation of addition and deletion of edges in a directed graph using adjacency matrix. • Implementation of insertion and deletion of vertices and edges in a directed graph using adjacency list. •	**04**	LO 4
V	Searching and Sorting	• Implementation of Heap Sort • Implementation of Binary Search. • Implementation of Selection sort, Bubble sort, Insertion sort, Quick sort	**04**	LO 5

VI	Applications of Data Structures	• *** Implementation of infix to postfix conversion and evaluation of postfix expression** • *** Implementation of Josephus Problem using circular linked list** • *** Implementation of traversal of a directed graph through BFS and DFS.** • Implementation of finding shortest distances using Dijkstra's algorithm • ***Implementation of hashing functions with different collision resolution techniques**	**04**	LO 6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL302	SQL Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL302	SQL Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To identify and define problem statements for real life applications
2	To construct conceptual data model for real life applications
3	To Build Relational Model from ER/EER and demonstrate usage of relational algebra.
4	To Apply SQL to store and retrieve data efficiently
5	To implement database connectivity using JDBC
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define problem statement and Construct the conceptual model for real life application.	L1, L3, L4, L6
2	Create and populate a RDBMS using SQL.	L3, L4
3	Formulate and write SQL queries for efficient information retrieval	L3, L4
4	Apply view, triggers and procedures to demonstrate specific event handling.	L1, L3, L4
5	Demonstrate database connectivity using JDBC.	L3
6	Demonstrate the concept of concurrent transactions.	L3, L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Any SQL Compiler, Java Programming Language

DETAILED SYLLABUS:

Sr. No.	Detailed Content	Hours	LO Mapping
1.	Identify real world problem and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.	**02**	LO1
2.	Mapping ER/EER to Relational schema model.	**02**	LO1
3.	Create a database using DDL and apply integrity constraints.	**02**	LO2, LO3
4.	Perform data manipulations operations on populated database.	**02**	LO3
5.	Perform Authorization using Grant and Revoke.	**02**	LO2, LO3
6.	Implement Basic and complex SQL queries.	**02**	LO3, LO4
7.	Implementation of Views and Triggers.	**02**	LO4
8.	Demonstrate database connectivity using JDBC.	**02**	LO5
9.	Execute TCL commands.	**02**	LO4
10.	Implement functions and procedures in SQL	**02**	LO3, LO4
11.	Implementation of Cursor.	**02**	LO3, LO4
12.	Implementation and demonstration of Transaction and Concurrency control techniques using locks.	**02**	LO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ―Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Term Work:

Term Work shall consist of at least 10 Practical's based on the above list, but not limited to. Also, Term work Journal must include at least 2 assignments:

The first assignment may be based on: Relational Algebra and Second may be based on Transactions

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL303	Computer programming Paradigms Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL303	Computer programming Paradigms Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Understand data abstraction and object orientation
2	Design and implement declarative programs in functional and logic programming languages
3	Introduce the concepts of concurrent program execution
4	Understand run time program management
5	Understand how to implement a programming solution using different programming paradigms.
6	Learn to compare implementation in different programming paradigms.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Implement Object Oriented concepts in C++.	L1, L2, L3
2	Design and Develop solution based on declarative programming paradigm using functional and logic programming.	L6
3	Understand the multi threaded programs in Java and C++	L1, L2
4	Understand the need and use of exception handling and garbage collection in C++ and JAVA	L2, L3
5	Implement a solution to the same problem using multiple paradigms.	L6
6	Compare the implementations in multiple paradigms at coding and	L4

	execution level.	

Prerequisite: Students must have learned C Programming (FEC205 and FEL204)

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	C++ compiler, Java Languge support, SWI Prolog, GHC Compiler.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Demonstrate Compilation and interpretation stages to students for C, C++, JAVA along with how to debug the code.	**02**	--
I	Imperative Paradigm: Data Abstraction in Object Orientation	At least two Programming Implementations Preferably in C++ to demonstrate concepts like - Encapsulation, Inheritance, Initialization and Finalization, Dynamic Binding.	**05**	LO1
II	Declarative Programming Paradigm: Functional Programming	• Tutorial Introduction to Haskell programming environment • Tutorial exercise on operators, types etc. in Haskell • At least 5 Haskell Programs to demonstrate Functional Programming Concepts. • Sample Programs but not limited to: ◦ Implement safetail function that behaves in the same way as tail, except that safetail maps the empty list to the empty list, whereas tail gives an error in this case. Define safetail using: (a) a conditional expression; (b) guarded equations; (c) pattern matching. Hint: the library function null :: [a]-> Bool can be used to test if a list is empty. ◦ Simple List Comprehension ◦ Higher-Order Functions ◦ Write recursive function to multiply two natural numbers that uses pre defined add funion. ◦ Implement the game of nim in Haskell to apply list processing. ◦ Haskell code to represent infinite list e.g. fibobacci series ◦ Implement simple Calculator Students should clearly understand the syntax and the execution of the Functional Implementation using Haskell.	**06**	LO2

III	Declarative Programming Paradigm: Logic Programming	• Tutorial Installation and working of SWI Prolog Environment • Implement at least 5 Prolog programs to understand declarative programming concepts. Students should clearly understand the syntax and the execution of the Prolog code Implementation.	**05**	LO2
IV	Alternative Paradigms: Concurrency	At least two Programs preferably in c++ and java to demonstrate Thread management and synchronization	**02**	LO4
V	Run Time Program Management	A Program to understand Exception handling and Garbage collection, preferably in C++ and JAVA Students should understand the syntactic differences in the solutions in both Object Oriented Languages.	**02**	LO4
VI	Programming Assignment For comparative study of Different Paradigms	At Least two implementations each implemented on multiple paradigms like procedural, object oriented, functional, logic. The implementations should be done in a group of two/three students with appropriate difficulty level. Student should prepare small report and present the solution code and demonstrate execution for alternative solutions they build.	**04**	LO5, LO6

Text Books:

1. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
2. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition)
3. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016
4.

References:

1. Sethi R, Programming Languages Concepts and Constructs , 2nd Ed, Pearson Education
2. Yogesh Sajanikar, Haskell Cookbook, Packt Publishing, 2017

Online References:

Sr No	Website Description	Link
1	University Stuttgart Germany Lab Course on Programming Paradigms	http://software-lab.org/teaching/winter2019/pp/
2	Course at MIT Structure and Interpretation of Computer Programs [2019]	https://web.mit.edu/u/6.037
3	Edx Course Paradigms of Computer Programming – Fundamentals,	https://www.edx.org/course/paradigms-of-computer-programming-fundamentals
4	Tutorials point link for Haskel	https://www.tutorialspoint.com/haskell

Term Work: Term Work shall consist of at least 15 Practicals based on the above modules, but not limited to. Also, Term work Journal must include at least 3 tutorial reports and 01 report of programming assignment

as mentioned in module VI.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiments/Tutorials) + 5 Marks (Assignment write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & 1 Hr Practical exam will be held based on the above syllabus

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL304	Java Lab (SBL)	--	04	--	--	02	--	02

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL304	Java Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand the concepts of object-oriented paradigm in the Java programming language.
2	To understand the importance of Classes & objects along with constructors, Arrays ,Strings and vectors
3	To learn the principles of inheritance, interface and packages and demonstrate the concept of reusability for faster development.
4	To recognize usage of Exception Handling, Multithreading, Input Output streams in various applications
5	To learn designing, implementing, testing, and debugging graphical user interfaces in Java using Swings and AWT components that can react to different user events.
6	To develop graphical user interfaces using JavaFX controls.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamental concepts of Java Programing.	L1, L2
2	Use the concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.	L3
3	Demonstrate how to extend java classes and achieve reusability using Inheritance, Interface and Packages.	L3
4	Construct robust and faster programmed solutions to problems using concept of Multithreading, exceptions and file handling	L3
5	Design and develop Graphical User Interface using Abstract Window Toolkit and Swings along with response to the events.	L6
6	Develop Graphical User Interface by exploring JavaFX framework based on MVC architecture.	L6

Prerequisite: Basics of Computer Programming

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 2 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. JDK 1.8 or higher 3. Notepad ++ 4.JAVA IDEs like Netbeans or Eclipse	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basics of Computer Programming.	**02**	-
I	Java Fundamentals	**Overview of procedure and object oriented Programming**, Java Designing Goals and Features of Java Language. **Introduction to the principles of object-oriented programming**: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism. Keywords, Data types, Variables, Operators, Expressions, Types of variables and methods. **Control Statements**: If Statement, If-else, Nested if, switch Statement, break, continue. **Iteration Statements:** for loop, while loop, and do-while loop (Perform any 2 programs that covers Classes, Methods, Control structures and Looping statements) 1) Implement a java program to calculate gross salary & net salary taking the following data. Input: empno, empname, basic Process: DA=70% of basic HRA=30% of basic CCA=Rs240/- PF=10% of basic PT= Rs100/- 2) Five Bikers Compete in a race such that they drive at a constant speed which may or may not be the same as the other. To qualify the race, the speed of a racer must be more than the average speed of all 5 racers. Write a Java program to take as input the speed of each racer and print back the speed of qualifying racers. 3) Write a Java program that prints all real solutions to the quadratic equation $ax^2+bx+c = 0$. Read in a, b, c and use the quadratic formula. If the discriminate b^2-4ac is negative, display a message stating that there are no real solutions? 4) Write a Menu driven program in java to implement simple banking application. Application should read	**07**	LO1

		the customer name, account number, initial balance, rate of interest, contact number and address field etc. Application should have following methods. 1. createAccount() 2. deposit() 3. withdraw() 4. computeInterest() 5. displayBalance() 5)Write a menu driven Java program which will read a number and should implement the following methods 1. factorial() 2. testArmstrong() 3. testPalindrome() 4. testPrime() 5. fibonacciSeries() 6) Create a Java based application to perform various ways of Method overloading.		
II	Classes, objects, Arrays and Strings	**Classes & Objects**: Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Static members, Non-Static members Nested and Inner Classes. Static Initialization Block(SIB), Instance Initialization Block(IIB) **Constructors**: Parameterized Constructors, chaining of constructor, finalize() Method, Method overloading, Constructors Overloading. Recursion, Command-Line Arguments. Wrapper classes, InputBufferReader, OutputBufferReader, String Buffer classes, String functions. **Arrays & Vectors**: One and Two Dimensional arrays, Irregular arrays, dynamic arrays, Array List and Array of Object. (Perform any 3 programs that covers Classes & objects, Constructors, Command Line Arguments, Arrays/Vectors,String function and recursions). **Experiments:** 1) Write a program that would print the information (name, year of joining, salary, address) of three employees by creating a class named 'Employee'. The output should be as follows: Name Year of joining Address Robert 1994 64C- WallsStreat Sam 2000 68D- WallsStreat John 1999 26B- WallsStreat 2) Write a program to print the area of a rectangle by creating a class named 'Area' having two methods. First method named as 'setDim' takes length and breadth of rectangle as parameters and the second method named as 'getArea' returns the area of the rectangle. Length and breadth of rectangle are entered through keyboard. 3) Write a Java program to illustrate Constructor Chaining.	**07**	LO1 LO2

		4) Create a class 'Student' with three data members which are name, age and address. The constructor of the class assigns default values name as "unknown", age as '0' and address as "not available". It has two members with the same name 'setInfo'. First method has two parameters for name and age and assigns the same whereas the second method takes has three parameters which are assigned to name, age and address respectively. Print the name, age and address of 10 students. Hint - Use array of objects. 5) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. 6) Print the sum, difference and product of two complex numbers by creating a class named 'Complex' with separate methods for each operation whose real and imaginary parts are entered by user. 7)Write menu driven program to implement recursive Functions for following tasks. a) To find GCD and LCM b) To print n Fibonacci numbers c) To find reverse of number d) To solve 1 +2+3+4+.....+(n- l)+n 8) Print Reverse Array list in java by writing our own function.		
III	Inheritance, Packages and Interfaces.	**Inheritance**: Inheritance Basics, Types of Inheritance in Java, member access, using Super- to call superclass Constructor, to access member of super class(variables and methods), creating multilevel hierarchy, Constructors in inheritance, method overriding, Abstract classes and methods, using final, Dynamic Method Dispatch **Packages**: Defining packages, creating packages and Importing and accessing packages **Interfaces**: Defining, implementing and extending interfaces, variables in interfaces, Default Method in Interface ,Static Method in interface, Abstract Classes vs Interfaces. (Perform any 3 programs covering Inheritance, Interfaces and Packages). **Experiments** 1) Create a Teacher class and derive Professor/ Associate_Professor/Assistant_Professor class from Teacher class. Define appropriate constructor for all the classes. Also define a method to display information of Teacher. Make necessary assumptions as required. 2) Create a class Book and define a display method to display book information. Inherit Reference_Book and Magazine classes from Book class and override display method of Book class in Reference_Book and Magazine classes. Make necessary assumptions required.	**10**	LO1 LO3

3) A university has two types of students — graduate students and research students. The University maintains the record of name, age and programme of every student. For graduate students, additional information like percentage of marks and stream, like science, commerce, etc. is recorded; whereas for research students, additionally, specialization and years of working experience, if any, is recorded. Each class has a constructor. The constructor of subclasses makes a call to constructor of the superclass. Assume that every constructor has the same number of parameters as the number of instance variables. In addition, every subclass has a method that may update the instance variable values of that subclass. All the classes have a function display_student_info( ), the subclasses must override this method of the base class. Every student is either a graduate student or a research student.
Perform the following tasks for the description given above using Java :

(i) Create the three classes with proper instance variables and methods, with suitable inheritance.

(ii) Create at least one parameterised constructor for each class.

(iii) Implement the display_student_info( ) method in each class.

4) An employee works in a particular department of an organization. Every employee has an employee number, name and draws a particular salary. Every department has a name and a head of department. The head of department is an employee. Every year a new head of department takes over. Also, every year an employee is given an annual salary enhancement. Identify and design the classes for the above description with suitable instance variables and methods. The classes should be such that they implement information hiding. You must give logic in support of your design. Also create two objects of each class.

5) Consider a hierarchy, where a sportsperson can either be an athlete or a hockey player. Every sportsperson has a unique name. An athlete is characterized by the event in which he/she participates; whereas a hockey player is characterised by the number of goals scored by him/her.
Perform the following tasks using Java :

(i)Create the class hierarchy with suitable instance variables and methods.

(ii) Create a suitable constructor for each class.

(iii) Create a method named display_all_info with suitable parameters. This method should display all the information about the object of a class.

(iv) Write the main method that demonstrates polymorphism.

6) Create an interface vehicle and classes like bicycle,

		car, bike etc, having common functionalities and put all the common functionalities in the interface. Classes like Bicycle, Bike, car etc implement all these functionalities in their own class in their own way 7) Create a class "Amount In Words" within a user defined package to convert the amount into words. (Consider amount not to be more than 100000).		
IV	Exception Handling, Multithreading, Input Output streams	**Exception Handling:** Exception-Handling Fundamentals, Exception Types, Exception class Hierarchy, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally , Java's Built-in Exceptions, Creating Your Own Exception Subclasses **Multithreaded Programming:** The Java Thread Model and Thread Life Cycle, Thread Priorities, Creating a Thread, Implementing Runnable, Extending Thread, Creating Multiple Threads, Synchronization: Using Synchronized Methods, The synchronized Statement **I/O Streams:** Streams, Byte Streams and Character, The Predefined Streams, Reading Console Input, Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files. (Perform any 3 programs that cover Exception Handling, Multithreading and I/O Streams). **Experiments:** 1) Write java program where user will enter loginid and password as input. The password should be 8 digit containing one digit and one special symbol. If user enter valid password satisfying above criteria then show "Login Successful Message". If user enter invalid Password then create InvalidPasswordException stating Please enter valid password of length 8 containing one digit and one Special Symbol. 2) Java Program to Create Account with 1000 Rs Minimum Balance, Deposit Amount, Withdraw Amount and Also Throws LessBalanceException. It has a Class Called LessBalanceException Which returns the Statement that Says WithDraw Amount(_Rs) is Not Valid. It has a Class Which Creates 2 Accounts, Both Account Deposite Money and One Account Tries to WithDraw more Money Which Generates a LessBalanceException Take Appropriate Action for the Same. 3) Create two threads such that one thread will print even number and another will print odd number in an ordered fashion. 4) Assume that two brothers, Joe and John, share a common bank account. They both can, independently, read the balance, make a deposit, and withdraw some	**10**	LO1 LO3 LO4

		money. Implement java application demonstrate how the transaction in a bank can be carried out concurrently. 5) You have been given the list of the names of the files in a directory. You have to select Java files from them. A file is a Java file if it's name ends with ".java". For e.g. File- "Names.java" is a Java file, "FileNames.java.pdf" is not. **Input:** test.java, ABC.doc, Demo.pdf, add.java, factorial.java, sum.txt **Output:** tset.java, add.java, factorial.java		
V	GUI programming- I (AWT, Event Handling, Swing)	**Designing Graphical User Interfaces in Java**: Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features **Event-Driven Programming in Java**: Event-Handling Process, Event-Handling Mechanism, Delegation Modelof Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling. **Introducing Swing:** AWT vs Swings, Components and Containers, Swing Packages, A Simple Swing Application, Painting in Swing, Designing Swing GUI Application using Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, TablesScroll pane Menus and Toolbar (Perform any 3 programs that contain AWT, Event handling and Swing to build GUI application). 1)Write a Java program to implement Swing components namely Buttons, ,JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, Tables Scroll pane Menus and Toolbars to design interactive GUI. 2) Write a program to create a window with four text fields for the name, street, city and pincode with suitable labels. Also windows contains a button MyInfo. When the user types the name, his street, city and pincode and then clicks the button, the types details must appear in Arial Font with Size 32, Italics. 3) Write a Java program to create a simple calculator using java AWT elements. .Use a grid layout to arrange buttons for the digits and basic operation +, -, /, *. Add a text felid to display the results. 4) Write a Java Program to create a Student Profile form using AWT controls. 5) Write a Java Program to simulate traffic signal light using AWT and Swing Components.	**12**	LO1 LO4 LO5

		6) Write a Java Program to create a color palette. Declare a grid of Buttons to set the color names. Change the background color by clicking on the color button. 7) Build a GUI program that allows the user to add objects to a collection and perform search and sort on that collection.(Hint. Use Swing components like JButton, JList, JFrame, JPanel and JOptionPane.)		
VI	GUI Programming-II (JavaFX)	JavaFX Basic Concepts, JavaFX application skeleton, Compiling and running JavaFX program,Simple JavaFX control:Label,Using Buttons and events, Drawing directly on Canvas. (Perform any one program that contains the concept of JavaFX). 1)Write a Java program to design a Login Form using JavaFX Controls. 2)Write Java program to draw various shapes on Canvas using JavaFX.	**04**	LO1 LO5 LO6

Text Books:

1. Herbert Schildt, "Java-The Complete Reference", Tenth Edition, Oracle Press, Tata McGraw Hill Education.
2. E. Balguruswamy, "Programming with Java A primer", Fifth edition, Tata McGraw Hill Publication
3. Anita Seth, B.L.Juneja, " Java One Step Ahead", oxford university press.

References:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press.

2. Learn to Master Java by Star EDU Solutions

3. Yashvant Kanetkar, "Let Us Java" ,4th Edition ,BPB Publications.

Term Work:

The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus**.**

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project. Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : 1 hour per week per four groups

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC401	Engineering Mathematics-IV	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC401	Engineering Mathematics-IV	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To study Matrix algebra and its application in engineering problems.
2	To learn Line and Contour integrals and expansion of complex valued function in a power series.
3	To study Z-Transforms and Inverse Z-Transforms with its properties.
4	To acquaint with the concepts of probability distributions and sampling theory for small samples.
5	To study and apply Linear and Non-linear programming Techniques to solve the optimization problems

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply the concepts of eigen values and eigen vectors to solve engineering problems.	L1, L2, L3
2	Illustrate the use of concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.	L3
3	Apply the concept of Z- transformation and its inverse in engineering problems.	L1,L2,L3

4	Apply the concept of probability distribution to engineering problems & testing hypothesis of small samples using sampling theory.	L3
5	Apply the concept of Linear Programming to solve the optimization problems	L1, L2, L3
6	Use the Non-Linear Programming techniques to solve the optimization problems.	L3

Module	Detailed Contents	Hours	CO Mapping
01	**Module: Linear Algebra (Theory of Matrices)** 1.1 Characteristic Equation, Eigenvalues and Eigenvectors and properties (without proof) 1.2 Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials 1.3 Similarity of matrices, diagonalizable and non-diagonalizable matrices **Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	7	CO1
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	7	CO2
03	**Module: Z Transform** 3.1 Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}, \{a^{\lvert k\rvert}\}, \{^{k+n}_{n}C.\, a^k\}, \{c^k \sin(\alpha k+\beta)\}, \{c^k \sinh \alpha k\}, \{c^k \cosh \alpha k\}$. 3.2 Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem. 3.3 Inverse Z transform: Partial Fraction Method, Convolution Method. **Self-learning Topics:** Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	5	CO3
04	**Module: Probability Distribution and Sampling Theory** 4.1 Probability Distribution: Poisson and Normal distribution 4.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 4.3 Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table. **Self-learning Topics:** Test significance for Large samples, Estimate parameters of a population., Yate's Correction.	7	CO4
05	**Module: Linear Programming Problems**	6	

	5.1 Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method. 5.2 Artificial variables, Big-M method (Method of penalty) 5.3 Duality, Dual of LPP and Dual Simplex Method **Self-learning Topics: Sensitivity** Analysis, Two-Phase Simplex Method, Revised Simplex Method		CO5
06	**Module: Nonlinear Programming Problems** 6.1 NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers 6.2 NLPP with two equality constraints 6.3 NLPP with inequality constraint: Kuhn-Tucker conditions **Self-learning Topics:** Problems with two inequality constraints, Unconstrained optimization: One dimensional search method (Golden Search method, Newton's method). Gradient Search method	7	CO6

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
3. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
5. Operations Research: An Introduction, Hamdy A Taha, Pearson.
6. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell.
7. Operations Research, Hira and Gupta, S. Chand Publication.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC402	Computer Network and Network Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC402	Computer Network and Network Design	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Understand the division of network functionalities into layers.
2	Understand the types of transmission media along with data link layer concepts, design issues and protocols
3	Analyze the strength and weaknesses of routing protocols and gain knowledge about IP addressing
4	Understand the data transportation, issues and related protocols for end to end delivery of data.
5	Understand the data presentation techniques used in presentation layer & client/server model in application layer protocols.
6	Design a network for an organization using networking concepts

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the functionalities of each layer of the models and compare the Models.	L1
2	Categorize the types of transmission media and explain data link layer concepts, design issues and protocols.	L2, L3, L4
3	Analyze the routing protocols and assign IP address to networks.	L4
4	Explain the data transportation and session management issues and related protocols used for end to end delivery of data.	L1, L2
5	List the data presentation techniques and illustrate the client/server model in application layer protocols.	L1, L3
6	Use of networking concepts of IP address, Routing, and application services to design a network for an organization	L3

Prerequisite: PCOM

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Terminologies of communication	**02**	-
I	**Introduction to Computer Networks**	Uses Of Computer Networks, Network Hardware, Network Software, Protocol Layering, Reference Models: OSI, TCP/IP, Comparison of OSI & TCP/IP, Network Devices. **Self-learning Topics:** Identify the different devices used in Network connection. College campus	**03**	CO1
II	**Physical Layer & Data Link Layer**	**Physical layer:** Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching, Structure Of A Switch **DLL Design Issues** (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code,Parity, CRC, Checksum) , Elementary Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking, HDLC **Medium Access Protocols:** Random Access, Controlled Access, Channelization. Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet. **Self-learning Topics:** Differentiate link layer in IOT network and Normal Network.	**08**	CO2
III	**Network Layer**	Network Layer Services, Packet Switching, Network Layer Performance, IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT). **Routing algorithms**: Distance Vector Routing, Link state routing,Path Vector Routing. **Protocols** –RIP,OSPF,BGP. **Next Generation IP:** IPv6 Addressing,IPv6 Protocol, Transition fromIPV4 to IPV6 **Self-learning Topics:** Study difference between IPV4 and IPV6. Network Class A, B, C, D, E and subnet mask.	**08**	CO3

IV	**Transport Layer & Session Layer**	**Transport Layer:** Transport Layer Services, Connectionless & Connection-oriented Protocols, Transport Layer protocols: User Datagram Protocol: UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers. **Session Layer:** Session layer design issues, Session Layer protocol - Remote Procedure Call (RPC), **Self-learning Topics:** List real time example of UDP and TCP.	**07**	CO4
V	**Presentation Layer & Application Layer**	**Presentation layer** :Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, Speech Compression, LZW, RLE, Image Compression – GIF,JPEG. **Application layer:** Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP **Self-learning Topics:** Difference between HTTP and FTP Protocol.	**05**	CO5
VI	**Network Design Concepts**	Introduction to VLAN ,VPN A case study to design a network for an organization meeting the following guidelines: Networking Devices, IP addressing: Subnetting, Supernetting, Routing Protocols to be used, Services to be used: TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server. **Self-learning Topics:** Study the Network Design of your college campus.	**06**	CO6

Text Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.
2. Behrouz A. Forouzan, Data Communications and Networking ,4th Edition,Mc Graw Hill education.

References:

1. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2.B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGrawHill , Second Edition.
4. Khalid Sayood, Introduction to Data Compression, Third Edition, Morgan Kaufman.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC403	Operating System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC403	Operating System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the major components of Operating System &its functions.
2	To introduce the concept of a process and its management like transition, scheduling, etc.
3	To understand basic concepts related to Inter-process Communication (IPC) like mutual exclusion, deadlock, etc. and role of an Operating System in IPC.
4	To understand the concepts and implementation of memory management policies and virtual memory.
5	To understand functions of Operating System for storage management and device management.
6	To study the need and fundamentalsof special-purpose operating system with the advent of new emerging technologies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to Operating System.	L1, L2
2	Describe the process management policies and illustrate scheduling of processes by CPU.	L1
3	Explain and apply synchronization primitives and evaluate deadlock conditionsas handled by Operating System.	L2
4	Describe and analyze the memory allocation and management functions of Operating System.	L1
5	Analyze and evaluate the services provided by Operating System for storage management.	L4, L5
6	Compare the functions of various special-purpose Operating Systems.	L2

Prerequisite: Programming Language C

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Programming Language C; Basic of Hardware i.e. ALU, RAM, ROM, HDD, etc.; Computer-System Organization.	**02**	-
I	Fundamentals of Operating System	Introduction to Operating Systems; Operating System Structure and Operations; Functions of Operating Systems; Operating System Services and Interface; System Calls and its Types; System Programs; Operating System Structure; System Boot. **Self-learning Topics:** Study of any three different OS. System calls with examples for different OS.	**03**	CO1
II	Process Management	Basic Concepts of Process; Operation on Process; Process State Model and Transition; Process Control Block; Context Switching; Introduction to Threads; Types of Threads, Thread Models; Basic Concepts of Scheduling; Types of Schedulers; Scheduling Criteria; Scheduling Algorithms. **Self-learning Topics:** Performance comparison of Scheduling Algorithms, Selection of Scheduling Algorithms for different situations, Real-time Scheduling	**06**	CO2
III	ProcessCoordination	Basic Concepts of Inter-process Communication and Synchronization; Race Condition; Critical Region and Problem; Peterson's Solution; Synchronization Hardware and Semaphores; Classic Problems of Synchronization; Message Passing; Introduction to Deadlocks; System Model, Deadlock Characterization; Deadlock Detection and Recovery; Deadlock Prevention; Deadlock Avoidance. **Self-learning Topics:** Study a real time case study for Deadlock detection and recovery.	**09**	CO3
IV	Memory Management	Basic Concepts of Memory Management; Swapping; Contiguous Memory Allocation; Paging; Structure of Page Table; Segmentation; Basic Concepts of Virtual Memory; Demand Paging, Copy-on Write; Page Replacement Algorithms; Thrashing. **Self-learning Topics:** Memory Management for any one Operating System, Implementation of Page Replacement Algorithms.	**09**	CO4

V	Storage Management	Basic Concepts of File System; File Access Methods; Directory Structure; File-System Implementation; Allocation Methods; Free Space Management; Overview of Mass-Storage Structure; Disk Structure; Disk Scheduling; RAID Structure; Introduction to I/O Systems. **Self-learning Topics:** File System for Linux and Windows, Features of I/O facility for different OS.	**06**	CO5
VI	Special-purpose Operating Systems	Open-source and Proprietary Operating System; Fundamentals of Distributed Operating System; Network Operating System;Embedded Operating Systems;Cloud and IoT Operating Systems; Real-Time Operating System;Mobile Operating System; Multimedia Operating System;Comparison between Functions of various Special-purpose Operating Systems. **Self-learning Topics:** Case Study on any one Special-purpose Operating Systems.	**04**	CO6

Text Books:

1. A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, 10th ed., Wiley, 2018.
2. W. Stallings, Operating Systems: Internal and Design Principles, 9th ed., Pearson, 2018.
3. A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.

Reference Books:

1. N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014.
2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd ed., Pearson.
3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC404	Automata Theory	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC404	Automata Theory	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn fundamentals of Regular and Context Free Grammars and Languages.
2	To understand the relation between Regular Language and Finite Automata and machines.
3	To learn how to design Automata's as Acceptors, Verifiers and Translators.
4	To understand the relation between Regular Languages, Contexts free Languages, PDA and TM.
5	To learn how to design PDA as acceptor and TM as Calculators.
6	To learn applications of Automata Theory.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain, analyze and design Regular languages, Expression and Grammars.	L2, L4, L6
2	Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.	L6
3	Analyze and design Context Free languages and Grammars.	L4, L6
4	Design different types of Push down Automata as Simple Parser.	L6
5	Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine.	L6
6	Develop understanding of applications of various Automata.	L6

Prerequisite: Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.	**02**	-
I	Introduction and Regular Languages	Languages: Alphabets and Strings. Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL grammars, Closure properties **Self-learning Topics:** Practice exercise on Regular Expressions. Identify the tools also.	**05**	CO1
II	Finite Automata	Finite Automata: FA as language acceptor or verifier, NFA (with and without ε) , DFA, RE to NFA, NFA to DFA, Reduced DFA , NFA-DFA equivalence, FA to RE. Finite State Machines with output : Moore and Mealy machines. Moore and Mealy M/C conversion. Limitations of FA. **Self-learning Topics:** Practice exercise on FA and NFA	**09**	CO2
III	Context Free Grammars	Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification and Normalization (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3) **Self-learning Topics:** Practice numerical or exercise on CFG	**08**	CO3
IV	Push Down Automata	Push Down Automata: Deterministic (single stack) PDA, Equivalence between PDA and CFG. Power and Limitations of PDA. **Self-learning Topics:** List the examples of PDA.	**05**	CO4
V	Turing Machine	Turing Machine: Deterministic TM, Variants of TM, Halting problem, Power of TM. **Self-learning Topics:** Practice numerical of TM.	**07**	CO5
VI	Applications of Automata	Applications of FA, CFG, PDA & TM. Introduction to Compiler & Its phases. **Self-learning Topics:** Case study on any one compiler.	**03**	CO2,CO 3, CO4,CO 5, CO6

Text books

1. J.C.Martin, "Introduction to languages and the Theory of Computation", TMH.
2. Kavi Mahesh, "Theory of Computation A Problem Solving Approach", Wiley India
3. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman , "Compilers Principles, Techniques and Tools ",Pearson Education.

References

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education.
2. Daniel I.A. Cohen, "Introduction to Computer Theory", John Wiley & Sons.
3. Vivek Kulkarni," Theory of Computation", Oxford University.
4. N.Chandrashekhar, K.L.P. Mishra, "Theory of Computer Science, Automata Languages & Computations", PHI publications.
5.J. J. Donovan, " Systems Programming", TMH.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://online.stanford.edu
3.	https://www.coursera.org/

Assessment:

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- A total of **four questions** need to be answered

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC405	Computer Organization and Architecture	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC405	Computer Organization and Architecture	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Learn the fundamentals of Digital Logic Design.
2	Conceptualize the basics of organizational and features of a digital computer.
3	Study microprocessor architecture and assembly language programming.
4	Study processor organization and parameters influencing performance of a processor.
5	Analyse various algorithms used for arithmetic operations.
6	Study the function of each element of memory hierarchy and various data transfer techniques used in digital computer.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate the fundamentals of Digital Logic Design	L1, L2
2	Describe basic organization of computer, the architecture of 8086 microprocessor and implement assembly language programming for 8086 microprocessors.	L1
3	Demonstrate control unit operations and conceptualize instruction level parallelism.	L1, L2
4	List and Identify integers and real numbers and perform computer arithmetic operations on integers.	L1,L4
5	Categorize memory organization and explain the function of each element of a memory hierarchy.	L4
6	Examine different methods for computer I/O mechanism.	L3

Prerequisite: Basics of Electrical Engineering, Fundamentals of Computer.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basics of Electrical Engineering, Fundamentals of Computer	**02**	
I	**Fundamentals of Logic Design**	Number systems: Introduction to Number systems, Binary Number systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal number and their conversions, 1's and 2's complement Combinational Circuits: NOT,AND,OR,NAND,NOR,EX-OR,EX-NOR Gates. Half & Full Adder and subtractor, Reduction of Boolean functions using K-map method (2,3,4 Variable), introduction to Multiplexers and Demultiplexers, Encoders & Decoders. Sequential Circuits: Introduction to Flip Flops: SR, JK, D, T, master slave flip flop, Truth Table. **Self-learning Topics:** Number System, Quine-McCluskey,Flip-Flop conversion, Counter Design.	**07**	CO1
II	**Overview of Computer Architecture & Organization**	Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture, Amdahl's Law Architecture of 8086 Family, Instruction Set, Addressing Modes, Assembler Directives, Mixed-Language Programming, Stack, Procedure, Macro. **Self-learning Topics:** Interfacing of I/O devices with 8086(8255,ADC,DAC).	**08**	CO2
III	**Processor Organization and Architecture**	CPU Architecture, Instruction formats, basic instruction cycle with Interrupt processing. Instruction interpretation and sequencing. Control Unit: Soft wired (Microprogrammed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations, concepts of nano programming. Introduction to parallel processing concepts, Flynn's classifications, instruction pipelining, pipeline hazards. **Self-learning Topics**: Study the examples on instruction pipelining for practice.	**07**	CO3
IV	**Data Representation and Arithmetic Algorithms**	Booth's algorithm. Division of integers: Restoring and non-restoring division, signed division, basics of floating-point representation IEEE 754 floating point (Single & double precision) number representation. **Self-learning Topics:** Implement Booth's Algorithm and Division methods.	**04**	CO4
V	**Memory Organization**	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics. Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory	**07**	CO5

		Self-learning Topics: Case study on Memory Organization, Numerical on finding EAT, Address mapping.		
VI	**I/O Organization**	Input/output systems, I/O module-need & functions and Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA **Self-learning Topics:** Comparison of all I/O methods.	**04**	CO6

Text Books:

1. R. P. Jain,"Modern Digital Electronics", TMH
2. M. Morris Mano,"Digital Logic and Computer Design", PHI
3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, Fifth Edition, Tata McGraw-Hill.
4. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition,, Pearson
5. John Uffenbeck, 8086/8088 family: Design Programming and Interfacing, (Pearson Education

References:

1. A. Anand Kumar, "Fundamentals of Digital Circuits",. PHI
2. Donald P Leach, Albert Paul Malvino, "Digital Principals & Applications", TMH.
3. B. Govindarajulu,, Computer Architecture and Organization: Design Principles and Applications, Computer Architecture and Organization: Design Principles and Applications, Tata McGraw-Hill
4. Dr. M. Usha, T. S. Srikanth, Computer System Architecture and Organization, First Edition, Wiley-India.
5. John P. Hayes, Computer Architecture and Organization, Third Edition., McGraw-Hill
6. K Bhurchandi, Advanced Microprocessors & Peripherals, Tata McGraw-Hill Education

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.geeksforgeeks.org
3.	https://www.coursera.org/

Assessment:

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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL401	Network Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL401	Network Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To get familiar with the basic network administration commands
2	To install and configure network simulator and learn basics of TCL scripting.
3	To understand the network simulator environment and visualize a network topology and observe its performance
4	To implement client-server socket programs.
5	To observe and study the traffic flow and the contents of protocol frames.
6	To design and configure a network for an organization

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Execute and evaluate network administration commands and demonstrate their use in different network scenarios	L3, L5
2	Demonstrate the installation and configuration of network simulator.	L1, L2
3	Demonstrate and measure different network scenarios and their performance behavior.	L1, L2
4	Implement the socket programming for client server architecture.	L3
5	Analyze the traffic flow of different protocols	L4
6	Design a network for an organization using a network design tool	L6

Prerequisite: C /Java

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	NS2.34, Protocol Analyzer (eg. Wireshark), C/Java/python

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Programming Language (C/Java), Basic commands of windows and Unix/Linux operating system. editor commands (eg nano/vi editor etc)	**02**	-
I	**Fundamentals of Computer Network**	Understanding Basic networking Commands: ifconfig ,ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump • Execute and analyze basic networking commands.	**02**	LO1
II	**Basics of Network simulation**	Installation and configuration of NS2. Introduction to Tcl Hello Programming • Installation and configuring of NS-2 simulator and introduction to Tcl using Hello program	**02**	LO2
III	**Simulation of Network Topology with different Protocols**	Implementation of Specific Network topology with respect to 1. Number of nodes and physical layer configuration 2. Graphical simulation ofnetwork with RoutingProtocols(Distance Vector/ Link State Routing) and trafficconsideration (TCP, UDP)using NAM. 3. Analysis of networkperformance for quality ofservice parameters such aspacket-delivery-ratio, delayand throughput 4. Comparative analysis of routing protocols with respect to QOS parametersusing Xgraph/gnuplot fordifferent load conditions. • Write TCL scripts to create topologies. Create and run traffics and analyze the result using NS2 • Write TCL scripts for topology with Graphical simulation of traffic consideration (TCP, UDP) using NAM and plot the graph • Implement distance vector and link state routing protocols in NS2.	**06**	LO3 LO5
IV	**Socket Programming**	Socket Programming with C/Java/python 1. TCP Client, TCP Server 2. UDP Client, UDP Server • To study and Implement Socket Programming using TCP.	**04**	LO4

		• To study and Implement Socket Programming using UDP		
V	**Protocol Analyzer**	1. Study of various Network Protocol Analyzer Tools likeWireshark, tcpdump, Windump, Microsoft Message Analyzer, Ettercap, Nirsoft SmartSniff etc. 2. Install one of the Network protocol analyzer tools and analyze the traffic • Study various network protocol analyzer tools and analyze the network traffics using one of the network protocol analyzer tools.	**04**	LO5
VI	**Network Design**	Network Design for an organization using the following concepts: 1. Addressing (IP Address Assignment), 2. Naming (DNS) 3. Routing • Perform remote login using Telnet Server • Design a network for an organization using the concepts of Addressing (IP Address Assignment), Naming (DNS) and Routing. Also mention the internetworking devices used	**06**	LO6

Text Books:

1. Computer Network Simulation in NS2 Basic Concepts and Protocol Implementation.-Prof Neeraj Bhargava,Pramod Singh Rathore,Dr.Ritu Bhargava,Dr.Abhishek Kumar, First Edition.BPB Publication.
2. Packet analysis with Wire shark, Anish Nath, PACKT publishing
3. TCP/IP Protocol Suite 4th Edition by Behrouz A. Forouzan

References:

1. NS2.34 Manual
2. Practical Packet Analysis: Using Wireshark to Solve Real-World Network Problems by Chris Sanders

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL402	Unix Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL402	Unix Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand architecture and installation of Unix Operating System
2	To learn Unix general purpose commands and programming in Unix editor environment
3	To understand file system management and user management commands in Unix.
4	To understand process management and memory management commands in Unix
5	To learn basic shell scripting.
6	To learn scripting using awk and perl languages.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the architecture and functioning of Unix	L1, L2
2	Identify the Unix general purpose commands	L4
3	Apply Unix commands for system administrative tasks such as file system management and user management.	L3
4	Execute Unix commands for system administrative tasks such as process management and memory management	L4
5	Implement basic shell scripts for different applications.	L3
6	Implement advanced scripts using awk & perl languages and grep, sed, etc. commandsfor performing various tasks.	L3

Prerequisite: Programming Language C

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Unix, Editor, Bash shell, Bourne shell and C shell

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	Basic Programming Skills, Concepts of Operating System	**02**	-
I	Introduction to Unix	Case Study: Brief History of UNIX, Unix Architecture; Installation of Unix Operating System	**03**	LO1
II	Basic Commands	a) Execution of Unix General Purpose Utility Commands like echo, clear, exit, date, time, uptime, cal, cat, tty, man, which, history, id, pwd, whoami, ping, ifconfig, pr, lp, lpr, lpstat, lpq, lprm, cancel, mail, etc. b) Working with Editor Vi/other editor.	**03**	LO2
III	Commands for File System Management and User Management	a) Study of Unix file system (tree structure), file and directory permissions, single and multiuser environment. b) Execution of File System Management Commands like ls, cd, pwd, cat, mkdir, rmdir, rm, cp, mv, chmod, wc, piping and redirection, grep, tr, echo, sort, head, tail, diff, comm, less, more, file, type, wc, split, cmp, tar, find, vim, gzip, bzip2, unzip, locate, etc. c) Execution of User Management Commands like who, whoami, su, sudo, login, logout, exit, passwd, useradd/adduser, usermod, userdel, groupadd, groupmod, groupdel, gpasswd, chown, chage, chgrp, chfn, etc.	**04**	LO3
IV	Commands for Process Management and Memory Management	a) Execution of Process Management Commands like ps, pstree, nice, kill, pkill, killall, xkill, fg, bg, pgrep, renice, etc. b) Execution of Memory Management Commands like free, /proc/meminfo, top, htop, df, du, vmstat, demidecode, sar, pagesize, etc.	**04**	LO4
V	Basic Scripts	a) Study of Shell, Types of Shell, Variables andOperators b) Execute the following Scripts (at least 6): (i) Write a shell script to perform arithmetic operations. (ii) Write a shell script to calculate simple interest. (iii) Write a shell script to determine largest among three integer numbers. (iv) Write a shell script to determine a given year is leap year or not. (v) Write a shell script to print multiplication table of given number using while statement.	**04**	L02, L03, L05

		(vi) Write a shell script to search whether element is present is in the list or not. (vii) Write a shell script to compare two strings. (viii) Write a shell script to read and check if the directory / file exists or not, if not make the directory / file. (ix) Write a shell script to implement menu-driven calculator using case statement. (x) Write a shell script to print following pattern: * * * * * * * * * * (xi) Write a shell script to perform operations on directory like: display name of current directory; display list of directory contents; create another directory, write contents on that and copy it to a suitable location in your home directory; etc.		
VI	Advanced Scripts	a) Execute the following scripts using grep / sed commands: (i) Write a script using grep command to find the number of words character, words and lines in a file. (ii) Write ascriptusing egrep command to display list of specific type of files in the directory. (iii) Write a script using sed command to replace all occurrences of particular word in given a file. (iv) Write a script using sedcommand to print duplicated lines in input. b) Execute the following scripts using awk / perl languages: (i) Write an awk script to print all even numbers in a given range. (ii) Write an awk script to develop a Fibonacci series (take user input for number of terms). (iii) Write a perl script to sort elements of an array. (iv) Write a perl script to check a number is prime or not.	**06**	LO2, L03, L06

Text Books:

1. S. Das, Unix Concepts and Applications, 4th ed., McGraw Hill, 2017.
2. R. Michael, Mastering Unix Shell Scripting, 2nd ed., Wiley, 2008.
3. D. Ambawade, D. Shah, Linux Labs and Open Source Technologies, Dreamtech Press, 2014.

References:

1. Y. Kanetkar, Unix Shell Programming, BPB Publications, 2003.
2. B. Forouzan and R. Gilberg, Unix and Shell Programming, Cengage Learning, 2003.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL403	Microprocessor Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL403	Microprocessor Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn assembling and disassembling of PC
2	Design, simulate and implement different digital circuits
3	Get hands on experience with Assembly Language Programming.
4	Study interfacing of peripheral devices with 8086 microprocessor.
5	Realize techniques for faster execution of instructions and improve speed of operation and performance of microprocessors.
6	Write and debug programs in TASM/MASM/hardware kits

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate various components and peripheral of computer system	L2
2	Analyze and design combinational circuits	L4, L6
3	Build a program on a microprocessor using arithmetic & logical instruction set of 8086.	L3
4	Develop the assembly level programming using 8086 loop instruction set	L6
5	Write programs based on string and procedure for 8086 microprocessor.	L1
6	Design interfacing of peripheral devices with 8086 microprocessor.	L6

Prerequisite: Logic Design, Programming Languages(C, C++)

Hardware & Software Requirements:

NOTE: Programs can be executed on assembler or hardware boards.

Hardware Requirement:	**Software requirement:**
➢ Motherboard, RAM, Processor, Connectors, Cables, SMPS, HDD, Monitor, Graphics card (optional), and Cabinet. ➢ 8086 microprocessor experiment kits with specified interfacing study boards	➢ Microsoft Macro Assembler (TASM)/Turbo Assembler (TASM) ➢ Virtual simulator lab. ➢ Proteus design suite

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
I	PC Assembly	Study of PC Motherboard Technology (South Bridge and North Bridge), Internal Components and Connections used in computer system.	**02**	LO1
II	Implementation of combinational circuits	1. Verify the truth table of various logic gates (basic and universal gates) 2. Realize Half adder and Full adder 3. Implementation of MUX and DeMUX	**06**	LO2
III	Arithmetic and logical operations in 8086 Assembly language programming	1. Program for 16 bit BCD addition 2. Program to evaluate given logical expression. 3. Convert two digit Packed BCD to Unpacked BCD. (any two)	**05**	LO3
IV	Loop operations in 8086 Assembly language programming	1. Program to move set of numbers from one memory block to another. 2. Program to count number of 1's and 0's in a given 8 bit number 3. Program to find even and odd numbers from a given list 4. Program to search for a given number (any three)	**06**	LO4
V	String &Procedure in 8086 Assembly language programming	1. Check whether a given string is a palindrome or not. 2. Compute the factorial of a positive integer 'n' using procedure. OR Generate the first 'n' Fibonacci numbers.	**04**	LO5
VI	Interfacing with 8086 microprocessor	1. Interfacing Seven Segment Display 2. Interfacing keyboard matrix 3. Interfacing DAC (any one)	**03**	LO6

Text Books:

1. Scott Mueller, ”Upgrading and repairing PCs”, Pearson,
2. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
3. John Uffenbeck, “8086/8088 family: Design Programming and Interfacing:”Pearson Education

Reference Books:

1. M. Morris Mano, “Digital Logic and computer Design”, PHI
2. K Bhurchandi, “Advanced Microprocessors & Peripherals”, Tata McGraw-Hill Education

Term Work: Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL404	Python Lab (SBL)	--	04	--	--	02	--	02

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL404	Python Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Basics of python including data types, operator, conditional statements, looping statements, input and output functions in Python
2	List, tuple, set, dictionary, string, array and functions
3	Object Oriented Programming concepts in python
4	Concepts of modules, packages, multithreading and exception handling
5	File handling, GUI & database programming
6	Data visualization using Matplotlib, Data analysis using Pandas and Web programming using Flask

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the structure, syntax, and semantics of the Python language.	L1, L2
2	Interpret advanced data types and functions in python	L1, L2
3	illustrate the concepts of object-oriented programming as used in Python	L2
4	Create Python applications using modules, packages, multithreading and exception handling.	L6
5	Gain proficiency in writing File Handling programs ,also create GUI applications and evaluate database operations in python.	L1, L2
6	Design and Develop cost-effective robust applications using the latest Python trends and technologies	L6

Prerequisite: Structured Programming Approach & Java Programming Lab

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 2 GB RAM 3. Minimum 40 GB Hard disk 4. Network interface card	1. Windows or Linux Desktop OS 2. Python 3.6 or higher 3. Notepad ++ 4.Python IDEs like IDLE, Pycharm, Pydev, Netbeans or Eclipse 5. Mysql	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Python IDE installation and environment setup.	**02**	
I	**Basics of Python**	Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments, Basic data types (Numeric, Boolean, Compound) Operators: Arithmetic, comparison, relational, assignment, logical, bitwise, membership, identity operators, operator precedence Control flow statements: Conditional statements (if, if…else, nested if) Looping in Python (while loop, for loop, nested loops) Loop manipulation using continue, pass, break. Input/output Functions, Decorators, Iterators and Generators.	**08**	LO 1
II	**Advanced data types & Functions**	Lists: a) Defining lists, accessing values in list, deleting values in list, updating lists b) Basic list operations c) Built-in list functions Tuples: a) Accessing values in Tuples, deleting values in Tuples, and updating Tuples b) Basic Tuple operations c) Built-in Tuple functions Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary b) Basic Dictionary operations c) Built-in Dictionary functions Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set operations, c) Built-in Set functions Strings: a) String initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String functions Arrays: a) Working with Single dimensional Arrays: Creating, importing, Indexing, Slicing, copying and processing array arrays. b) Working with Multi-dimensional Arrays using Numpy: Mathematical operations, Matrix operations, aggregate and other Built-in functions	**09**	LO 1 LO 2

		Functions: a) Built-in functions in python b) Defining function, calling function, returning values, passing parameters c) Nested and Recursive functions d) Anonymous Functions (Lambda, Map, Reduce, Filter)		
III	**Object Oriented Programming**	Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python.	**08**	LO 1 LO 3
IV	**Exploring concept of modules, packages, multithreading and exception handling**	Modules: Writing modules, importing objects from modules, Python built-in modules (e.g. Numeric and Mathematical module, Functional Programming module, Regular Expression module), Namespace and Scoping. Packages: creating user defined packages and importing packages. Multi-threading: process vs thread, use of threads, types of threads, creating threads in python, thread synchronization, deadlock of threads. Exception handling: Compile time errors, Runtime errors, exceptions, types of exception, try statement, except block, raise statement, Assert statement, User-Defined Exceptions.	**06**	LO 1 LO 4
V	**File handling, GUI & database programming**	File Handling: Opening file in different modes, closing a file, writing to a file, accessing file contents using standard library functions, reading from a file – read (), readline (), readlines (), Renaming and Deleting a file, File Exceptions, Pickle in Python. Graphical user interface (GUI): different GUI tools in python (Tkinter, PyQt, Kivy etc.), Working with containers, Canvas, Frame, Widgets (Button, Label, Text, Scrollbar, Check button, Radio button, Entry, Spinbox, Message etc.) Connecting GUI with databases to perform CRUD operations. (on supported databases like SQLite, MySQL, Oracle, PostgreSQL etc.).	**09**	LO 1 LO 5
VI	**Data visualization, analysis and web programming using python**	Visualization using Matplotlib: Matplotlib with Numpy, working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.), working with multiple figures. Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python, series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates. SciPy: Linear algebra functions using Numpy and Scipy. Web programming: Introduction to Flask, Creating a Basic Flask Application, Build a Simple REST API using Flask	**10**	LO 1 LO 6

List of Experiments/Mini-Project.

1)	Write python programs to understand a) Basic data types, Operators, expressions and Input Output Statements b) Control flow statements: Conditional statements (if, if…else, nested if) c) Looping in Python (while loop, for loop, nested loops) d) Decorators, Iterators and Generators.
2)	Write python programs to understand a) Different List and Tuple operations using Built-in functions b) Built-in Set and String functions c) Basic Array operations on 1-D and Multidimensional arrays using Numpy d) Implementing User defined and Anonymous Functions
3)	Write python programs to understand a) Classes, Objects, Constructors, Inner class and Static method b) Different types of Inheritance c) Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python.
4)	Write python programs to understand a) Creating User-defined modules/packages and import them in a program b) Creating user defined multithreaded application with thread synchronization and deadlocks c) Creating a menu driven application which should cover all the built-in exceptions in python
5)	Write python programs to understand a) Different File Handling operations in Python b) Designing Graphical user interface (GUI) using built-in tools in python (Tkinter, PyQt, Kivy etc.). c) GUI database connectivity to perform CRUD operations in python (Use any one database like SQLite, MySQL, Oracle, PostgreSQL etc.)
6)	Write python programs to implement a) Different types of plots using Numpy and Matplotlob b) Basic operations using pandas like series, data frames, indexing, filtering, combining and merging data frames. c) Different Linear algebra functions using Scipy. d) A Basic Flask Application to build a Simple REST API.

- **Mini Project**

Mini-project have to be developed in a group of three students which should cover all above topics.
Suggested Mini-Project Topics:

1. Railway reservation system	27 IT Team Workspace	52. Business Directory	78. Practice Test Management.
2. Inventory Management system.	29 Job Requisition and Interview Management	53. Education Directory	79. Asset Management System
3 Classroom Management	28 Knowledge Base	54. Dental Clinic Management	80. Travel Agency System.
4 Clinical Trial Initiation and Management	29 Lending Library	55. Fund Raising Management	81. Placement Management System.

5 Competitive Analysis Web Site	30 Physical Asset Tracking and Management	56. Clinic/ Health Management	82. Polls Management
6 Discussion Forum website	31 Project Tracking Workspace	57. Cable Management System	83. Customer Management
7 Disputed Invoice Management	32. Shopping Cart .	58. Survey Creation and Analytics	84. Project Management System.
8 Employee Training Scheduling and Materials	33 Knowledge Base	59. Museum Management System	85. Network Marketing System
9 Equity Research Management	34 Lending Library	60. Multi-Level Marketing System	86. Yoga Health Care Management
10 Integrated Marketing Campaign Tracking	35 Physical Asset Tracking and Management	61. Learning Management System	87. Personal Finance Management System
11 Manufacturing Process Managements	36 Project Tracking Workspace	62. Knowledge Management System	88. Real Estate Management System
12 Product and Marketing Requirements Planning	37 Room and Equipment Reservations	63. Missing Person Site	89. Stock Mutual Funds Management
13 Request for Proposal Software	38 Sales Lead Pipeline	64. Disaster Management Site	90. Careers and Employment Management System
14 Sports League Management	39. Yellow Pages & Business Directory	65. Job Management Site	91. Music Albums Management System
15 Absence Request and Vacation Schedule Management	40. Time & Billing	66. Financial Portfolio Management	92. Classified Ads Managements
16 Budgeting and Tracking Multiple Projects	41. Class Room Management	67. Market Research Management	93. Property Management System
17 Bug Database Management	42. Expense Report Database	68. Order Management System	94. Sales & Retail Management
18 Call Center Management Software	43. Sales Contact Management Database	69. Point of Sale	95. Dating Site
19 Change Request Management	44. Inventory Management Database	70. Advertisement /Banner Management and Analytics	96. Hotel Management System
20 Compliance Process Support Site	45. Issue Database	71. Export Management System	97. Search Engine
21 Contacts Management Software	46. Event Management Database	72. Invoice Management	98. Online News Paper Site
22 Document Library and Review	47. Service Call Management Database	73. Recruitment Management System	99. Image Gallery
23 Event Planning and Management	48. Accounting Ledger Database	74. Articles / Blog / Wiki Web site	100. Staffing and Human Capital Management
24 Expense Reimbursement and Approval	49. Asset Tracking Database	75. Online Planner	101. Development of a feature-rich, practical Online Survey Tool (OST)
25 Help Desk and Ticket Management	50. Cycle Factory Works Management	76. Mock Tests and Examination Management	102 Development of a Web/Email based Search Engine
26 Inventory Tracking	51. Sales Corporation Management	77. Examination System	103. Development of a web-based Recruitment Process System for the HR group for a company

Text Books:

1. Dr. R. Nageswara Rao," Core Python Programming" , Dreamtech Press, Wiley Publication
2. M. T. Savaliya , R. K. Maurya, "Programming through Python", StarEdu Solutions.
3. E Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Publication.

References:

1. Zed A. Shaw, "Learn Python 3 the Hard Way", Zed Shaw's Hard Way Series.
2. Martin C. Brown," Python: The Complete Reference", McGraw-Hill Publication.
3. Paul Barry," Head First Python", 2nd Edition, O'Reilly Media, Inc.

Online resources:

1) https://docs.scipy.org/doc/numpy/user/quickstart.html
2) https://matplotlib.org/tutorials/
3) https://pandas.pydata.org/docs/getting_started/
4) https://www.geeksforgeeks.org/python-build-a-rest-api-using-flask/

Term Work:

The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus**.**

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM401	Mini Project – 1 B for Python based automation projects	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

AC 11.5.2017

Item No. 4.180

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Information Technology

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**

with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Co-ordinator,

Faculty of Technology,

Member - Academic Council

University of Mumbai, Mumbai

Preamble

It is an honor and a privilege to present the revised syllabus of Bachelor of Engineering in Information Technology (effective from year 2016-17) with inclusion of cutting edge technology.
Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement. The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions.
Industries views are that, only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain.
The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.
I would like to thank senior faculties of IT department of all colleges affiliated to Mumbai University for significant contribution in framing the syllabus. Also behalf of all faculties I thank all the industry experts for their valuable feedback and suggestions.
I sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology management and security to enterprise processes.
3. Manage IT projects using written and oral communication skills in collaborative environments by Participating on teams that address solutions for IT management challenges.
4. Identify and discuss professional, individual, organizational, societal, and regulatory implications of Information systems and technology.
5. Assess Security of the IT Systems and able to respond to any breach in IT system
6. Ability to work in multidisciplinary projects and make it IT enabled.
7. Ability to propose the system to reduce carbon footprint.
8. Ability to adapt the lifelong learning process to be in sync with trends in Information Technology

Dr. Deven Shah

Chairman (Ad-hoc Board Information Technology)
University of Mumbai)

University of Mumbai

Program Structure B.E. Information Technology, (Rev. 2016)

T. E. Information Technology (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC501	Microcontroller and Embedded Programming	4	-	-	4	-	-	4
ITC502	Internet Programming	4	-	-	4	-	-	4
ITC503	Advanced Data Management Technology	4	-	-	4	-	-	4
ITC504	Cryptography & Network Security	4	-	-	4	-	-	4
ITDLO-I	Department Level Optional Course-I	4	-	-	4	-	-	4
ITL501	Internet Programming Lab	-	2	-	-	1		1
ITL502	Security Lab	-	2	-	-	1	-	1
ITL503	OLAP Lab	-	2	-	-	1	-	1
ITL504	IOT (Mini Project) Lab	-	2	-	-	1	-	1
ITL505	Business Communication and Ethics	-	2+2*	-	-	2	-	2
	Total	**20**	**14**	-	**20**	**7**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC501	Microcontroller and Embedded Programming	20	20	20	80	3	-		-	100
ITC502	Internet Programming	20	20	20	80	3	-		-	100
ITC503	Advanced Data Management Technology	20	20	20	80	3	-		-	100
ITC504	Cryptography & Network Security	20	20	20	80	3	-		-	100
ITDLO-I	Department Level Optional Course-I	20	20	20	80	3	--		-	100
ITL501	Internet Programming Lab	-	-	-	-	-	25	--	25	50
ITL502	Security Lab	-	-	-	-	-	25	25	--	50
ITL503	OLAP Lab	-	-	-	-	-	25	25	--	50

ITL504	IOT (Mini Project) Lab	-	-	-	-	-	25	25	--	50
ITL505	Business Communication and Ethics	-	-	-	-	-	50	--	--	50
Total		100	100	100	400	-	150	75	25	750

 # Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester V. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Subject Code	**Department Level Optional Course** **(DLO)**
Semester V	
ITDLO5011	Advanced Data Structures & Analysis of Algorithms
ITDLO5012	Image Processing
ITDLO5013	E-Commerce & E-Business
ITDLO5014	IT Enabled Services
ITDLO5015	Computer Graphics & Virtual Reality

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC501	Microcontroller and Embedded Programming	04	--		04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC501	Microcontroller and Embedded Programming	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concepts and architecture of embedded systems
2. Basic of microcontroller 8051.
3. The concepts of microcontroller interface.
4. The concepts of ARM architecture
5. The concepts of real-time operating system
6. Different design platforms used for an embedded systems application

Course Outcomes: Students will be able to:

1. Explain the embedded system concepts and architecture of embedded systems
2. Describe the architecture of 8051 microcontroller and write embedded program for 8051 microcontroller.
3. Design the interfacing for 8051 microcontroller.
4. Understand the concepts of ARM architecture.
5. Demonstrate the open source RTOS and solve the design issues for the same.
6. Select elements for an embedded systems tool.

Prerequisite: COA, Microprocessors and Assembly Programming languages

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Revision of microcomputer system terminologies, High level, Machine level and Assembly level programming language , difference between microprocessor and microcontroller	02	

I	Introduction to Embedded systems	Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC.	05	CO1
II	The Microcontroller Architecture and Programming of 8051:	Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical Operations, I/O parallel and serial ports, Timers & Counters, and ISR.	14	CO2
III	Interfacing with 8051Microcontroller	Interfacing ADC, DAC, Stepper motor, LCD, KBD matrix, 8255 PPI	06	CO3
IV	ARM 7 Architecture	Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Instruction set: Data processing, Data Transfer, Control flow. Addressing modes. Writing simple assembly language programs. Pipelining, Brief introduction to exceptions and interrupts handling.	10	CO4
V	Open source RTOS	Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matrix in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues – selecting a Real Time Operating System, RTOS comparative study.	07	CO5
VI	Introduction to Embedded target boards	Introduction to Arduino, Raspberry Pi, ARM Cortex, Intel Galileo etc. Open-source prototyping platforms. Basic Arduino programming; Extended Arduino libraries; Arduino-based Internet communication; Raspberry pi; ARM	08	CO6

		Cortex Processors; Intel Galileo boards; Sensors and Interfacing: Temperature, Pressure, Humidity		

Text Books:

1. M. A. Mazidi, J. G. Mazidi, R. D., McKinlay ,"The 8051 microcontroller & Embedded systems Using Assembly and C", Pearson, 3rd edition
2. Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech press, Reprint edition 2013
3. Shibu K. V., "Introduction to embedded systems", McGraw Hil

References:

1. Laya B. Das, "Embedded systems an integrated approach", Pearson, Third impression, 2013
2. Steve Furber, "ARM System on chip Architecture", Pearson, edition second
3. Michael Margolis, "Arduino Cookbook", O'reilly
4. Simon Monk," Raspberry Pi Cookbok", O'reilly
5. Raspberry Pi User Guide.
6. Massimo Banzi, "Getting Started with Arduino: The Open Source Electronics Prototyping Platform (Make)", O'Reilly Media.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC502	Internet Programming	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC502	Internet Programming	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1 To get familiar with basics of the Internet Programming.
2. To acquire knowledge and skills for creation of web site considering both client and server side programming
3. To gain ability to develop responsive web applications
4. To explore different web extensions and web services standards
5. To learn characteristics of RIA –Web Mashup Eco System
6. To be familiarized with Python web framework-Django.

Course Outcomes: Students will be able to:

1. Implement interactive web page(s) using HTML,CSS and JavaScript.
2. Design a responsive web site using HTML5 and CSS3.
3. Demonstrate Rich Internet Application .
4. Build Dynamic web site using server side PHP Programming and Database connectivity.
5. Describe and differentiate different Web Extensions and Web Services.
6. Demonstrate web application using Python web Framework-Django

Prerequisite: Basic Java Programming and Python Programming.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Introduction to web technologies**: Introduction to OSI layers,	02	---
I	Client Side Programming :HTML, CSS and JavaScript	**Basic of HTML:** Web System architecture-1,2,3 and n tier architecture, URL, domain name system, overview of HTTP and FTP, Cross browser compatibility issues, W3C Validators. Formatting and Fonts, Anchors, images, lists, tables, frames and forms. **Introduction to CSS**: Evolution of CSS, Syntax of CSS, Exploring CSS Selectors, Inserting CSS in an HTML Document, Defining Inheritance in CSS. **Introduction to JavaScript:** JavaScript language constructs, Objects in JavaScript- Built in, Browser objects and DOM objects, event handling, form validation and cookies.	09	CO1
II	HTML5 and Responsive Web Design with CSS3	**HTML 5 :** Fundamental Syntax and Semantics, Native Audio and Video, Micro data and Custom data, Accessibility, Geo-location, Canvas **CSS3 and Responsive Web Design** Media Queries: Supporting Differing Viewports, Embracing Fluid Layout. CSS3: Selectors, Typography and color Modes, Stunning Aesthetics with CSS3, CSS3 Transitions, Transformations and Animations, Conquer Forms HTML5 and CSS3	12	CO1 CO2
III	Rich Internet Application(RIA)	Characteristics of RIA, **Introduction to AJAX** :AJAX design basics, AJAX vs Traditional Approach, , Rich User Interface using Ajax. **Working with JavaScript Object Notation(JSON)**: Create data in JSON format, JSON Parser .	09	CO3

		Web Mashup Eco Systems –Mashup Techniques: Mashing on the Web Server, Mashing with JSON		
IV	Server Side Programming: PHP	Introduction to PHP- Data types, control structures, built in functions, Building web applications using PHP- tracking users, PHP and Mysql database connectivity with example. Introduction to PHP Framework.	08	CO4
V	Web Extensions and Web Services	**Web Extensions**: Introduction to XML, Introducing XSL. Web services: Evolution and differences with Distributed computing, WSDL, SOAP, UDDI. REST-ful web services, Resource Oriented Architecture	07	CO5
VI	Python Web Framework: Django	Introduction, Web Frameworks, Introduction to Django ,Projects and Apps, "Hello World" Application.	05	CO6

Text Books:

1. HTML 5 Black Book: Kogent Learning solutions
2. "Learning PHP 5", David Sklar, O'Reilly Publication
3. Rich Internet Application AJAX and Beyond WROX press
4. Responsive Web Design with HTML5 and CSS3, Ben Frain, PACKT Publication

References:

1. "Web Technologies: Black Book", Dreamtech publication
2. HTML5 Cookbook, By Christopher Schmitt, Kyle Simpson, O'Reilly Media
3. Core Python Applications Programming by Wesley J Chun Third edition Pearson Publication
4. Advanced Internet Technologies (includes practicals), Deven Shah, Dreamtech publication

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC503	Advanced Data Management Technology	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC503	Advanced Data Management Technology	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. To introduce advanced concepts of transaction management and recovery techniques.
2. To impart knowledge related to query processing and query optimizer phases of a database management system
3. To introduce concepts of advanced access control techniques like role based and discretionary methods
4. To introduce advanced database models like distributed databases.
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

Course Outcomes: Students will be able to:

1. Explain and understand the concept of a transaction and how ACID properties are maintained when concurrent transaction occur in a database
2. Measure query costs and design alternate efficient paths for query execution**.**
3. Apply sophisticated access protocols to control access to the database.
4. Implement alternate models like Distributed databases and Design applications using advanced models like mobile, spatial databases**.**
5. Organize strategic data in an enterprise and build a data Warehouse.
6. Analyze data using OLAP operations so as to take strategic decisions.

Prerequisite: Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Reviewing basic concepts of a Relational database, SQL concepts	02	
I	Query Processing and Optimization:	Overview, Measures of Query Cost Selection Operation, Sorting, Join Operation, Other Operations Evaluation of Expressions. Query Optimization Overview, Transformation of Relational Expressions Estimating Statistics of Expression Results Choice of Evaluation Plans	06	CO1
II	Transactions Management and Concurrency:	Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Implementation of isolation, Concurrency Control: Lock-based, Time-stamp based Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Checkpoints, Shadow Paging, ARIES Algorithm.	10	CO2
III	Advanced Data Management techniques	Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges; Mandatory Access Control and Role-Based Access Control. Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases.	09	CO3 CO4
IV	Distributed Databases	Introduction : Distributed Data Processing, What is a Distributed Database System? Design Issues . Distributed DBMS Architecture. Distributed Database Design : Top-Down Design Process, Distribution Design Issues, Fragmentation , Allocation . Overview of Query Processing : Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing, Query Optimization in Distributed Databases;	09	CO4

		Overview of Transaction Management in DDB; Overview of Concurrency Control in DDB; Overview of Recovery in DDB		
V	Data Warehousing, Dimensional Modeling and OLAP	The Need for Data Warehousing; Data Warehouse Defined; Benefits of Data Warehousing ; Features of a Data Warehouse; Data Warehouse Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies. Dimensional Model Vs ER Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table; Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star Need for Online Analytical Processing; OLTP vs OLAP; OLAP Operations in a cube: Roll-up, Drill-down, Slice, Dice, Pivot ; OLAP Models: MOLAP, ROLAP, HOLAP.	10	CO5
VI	ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading, Loading the Fact Tables and Dimension Tables	06	CO6

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Theraja Reema, "Data Warehousing", Oxford University Press, 2009.
4. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill

References:

1. Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India.
2. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom “Database System Implementation”, Pearson Ltd. 1/ e
3. Thomas M. Connolly Carolyn Begg, Database Systems : A Practical Approach to Design, Implementation and Management, 4/e, Pearson Ltd.
4. Ralph Kimball, Margy Ross, “The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling”, 3rd Edition. Wiley India.
5. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC504	Cryptography & Network Security	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of two Tests					
ITC504	Cryptography & Network Security	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concepts of classical encryption techniques and concepts of finite fields and number theory.
2. And explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3. And explore the design issues and working principles of various authentication protocols, PKI standards.
4. And explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
5. The ability to use existing cryptographic utilities to build programs for secure communication.
6. The concepts of cryptographic utilities and authentication mechanisms to design secure applications

Course Outcomes: Students will be able to:

1. Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
2. Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes
4. Apply different digital signature algorithms to achieve authentication and create secure applications
5. Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.
6. Apply the knowledge of cryptographic utilities and authentication mechanisms to design secure applications

Prerequisite: Computer Networks

Detailed syllabus:

Sr No	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basic concepts of OSI Layer	02	--
I	Introduction & Number Theory	Services, Mechanisms and attacks-the OSI security architecture-Network security model-Classical Encryption techniques (Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vignere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography).	09	CO1
II	Block Ciphers & Public Key Cryptography	Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm. Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, El-Gamal Algorithm. Key management – Diffie Hellman Key exchange	09	CO2 CO6
III	Cryptographic Hashes, Message Digests and Digital Certificates	Authentication requirement – Authentication function , Types of Authentication, MAC – Hash function – Security of hash function and MAC –MD5 – SHA – HMAC – CMAC, Digital Certificate: X.509, PKI	09	CO3
IV	Digital signature schemes and authentication Protocols	Digital signature and authentication protocols : Needham Schroeder Authentication protocol, Digital Signature Schemes – RSA, EI Gamal and Schnorr, DSS.	07	CO4
V	Network Security	Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing. Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service, Defenses against Denial of Service Attacks.	10	CO5

		Firewalls, Intrusion Detection Systems: Host Based and Network Based IDS, Honey pots.		
VI	Network Security Applications	Authentication Applications, Kerberos, Internet Security Protocols: SSL, TLS, IPSEC:AH, ESP, Secure Email: PGP and S/MIME, Key Management.	06	CO5 CO6

Text Books:

1. Mark Stamp's Information Security Principles and Practice, Wiley
2. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013
3. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill
4. Bernard Menezes, "Cryptography & Network Security", Cengage Learning

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW /Practical	Tutorial	Total
ITL501	Internet Programming Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of two Tests				
ITL501	Internet Programming Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try:

1. To Acquire knowledge and Skills for creation of Web Site considering both client- and server-side Programming.
2. To create Web application using tools and techniques used in industry.
3. To learn the characteristics of RIA
4. To Demonstrate Amazon/Google or Yahoo mashup
5. To be well versed with XML and web services Technologies.
6. To be familiarized with open source Frameworks for web development.

Lab Outcomes: Students will learn to;

1. Design a basic web site using HTML5 and CSS3 to demonstrate responsive web design.
2. Implement dynamic web pages with validation using JavaScript objects by applying different event handling mechanism.
3. Use AJAX Programming Technique to develop RIA
4. Develop simple web application using server side PHP programing and Database Connectivity using MySQL.
5. Build well-formed XML Document and implement Web Service using Java.
6. Demonstrate simple web application using Python Django Framework.

Hardware and Software requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. HTML5 compatible web browsers(Chrome, Opera, Firefox, Safari etc) 3. HTML,CSS editors like Dreamweaver, Notepad++ etc. 4. Netbeans or Eclipse IDE 5. XAMPP	1. Internet Connection installation of web frameworks

Prerequisite: Basics of Java and Python Programming

Guidelines

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students may do will visit different websites to identify their website topic for the mini project.
4. Each group will identify the Hardware and software requirement for their mini project problem statement.
5. Mini Project consists of Responsive Website Development.
6. Which includes following points
    a. Introduction to RWD frame work?
    b. Identify tools
    c. CSS preprocessor
    d. Construction and design of skeleton for website
    e. Enhancing CSS3 and HTML5 in website
    f. Server Side Programming: website using server side scripting in PHP and database connectivity using MySQL (PHP framework like Laravel/Joomla can be used)
    g. XML ,XSL and Web Services

h. Developing RIA using AJAX including -A browser built-in XMLHttpRequest object (to request data from a web server) and JavaScript and HTML DOM (to display or use the data) Building Amazon/Yahoo /Google Web Mashups for the website.

i. Website Security

j. Develop full website and launch it.

7. Each group may present their work in various project competitions and paper presentations.

8. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Responsive Web Design by Example Beginner's Guide by Thoriq Firdaus, PACKT
2. Responsive Web Design with HTML5 and CSS3 PACKT
3. Professional Rich Internet Application : AJAX and Beyond WROX press

References:

1. Laravel: Up and Running, By Matt Stauffer O'Reilly Media.
2. Advanced Internet Technologies (includes practicals) ,Deven Shah ,Dreamtech publication
3. Django By Example By Antonio Melé,Pakt Publication

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW /Practical	Tutorial	Total
ITL502	Security Lab	--	2	-	--	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL502	Security Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers
2. To be able to analyze and implement public key algorithms like RSA and El Gamal
3. To analyze and evaluate performance of hashing algorithms
4. To explore the different network reconnaissance tools to gather information about networks
5. To explore and use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Lab Outcome: Students will learn to:

1. Apply the knowledge of symmetric cryptography to implement simple ciphers
2. Analyze and implement public key algorithms like RSA and El Gamal
3. Analyze and evaluate performance of hashing algorithms
4. Explore the different network reconnaissance tools to gather information about networks
5. Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
6. Apply and set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Hardware and Software requirements:

Hardware Requirements	**Software Requirements**
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. wireshark 3. ARPWATCH 4. Kismet, NetStumbler 5. NESSUS

Prerequisite: Computer Networks, Operating System, Basics of Java and Python Programming

Detail Syllabus:

Module No.	Description	Hours	CO mapping
I	a) Design and Implementation of a product cipher using Substitution and Transposition ciphers b) Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal	4	LO1 LO2
II	a) Implementation of Diffie Hellman Key exchange algorithm b) For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs c) Exploring wireless security tools like Kismet, NetStumbler etc.	4	LO2 LO3
III	a) Study the use of network reconnaissance tools like WHOIS, dig,traceroute, nslookup to gather information about networks and domain registrars. b)Study of packet sniffer tools wireshark, :- **1**. Observer performance in promiscuous as well as non-promiscuous mode. **2**. Show the packets can be traced based on different filters.	4	LO4 LO5
IV	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc.	4	LO5
V	a) Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark. b) Simulate DOS attack using Hping and other tools c) Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities.	6	LO4 LO5

VI	a) Set up IPSEC under LINUX. b) Set up Snort and study the logs. c) Explore the GPG tool of linux to implement email security	4	LO6

Text Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, TIm Boyles, Sybex

Reference Books:

1. Network Security Bible, Eric Cole, Wiley India

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL503	OLAP Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test	Test2	Avg. of two Tests					
ITL503	OLAP Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce advanced concepts of transaction management and recovery techniques.
2. To impart knowledge related to query processing and query optimizer phases of a database management system
3. To initiate awareness about the potential security threats that exists in database systems and how to tackle them.
4. To introduce advanced database models like distributed databases.
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

Lab Outcomes: Student should be able:

1. Implement simple query optimizers and design alternate efficient paths for query execution**.**
2. Simulate the working of concurrency protocols, recovery mechanisms in a database
3. Design applications using advanced models like mobile, spatial databases**.**
4. Implement a distributed database and understand its query processing and transaction processing mechanisms
5. Build a data warehouse
6. Analyze data using OLAP operations so as to take strategic decisions.

Hardware and Software requirements:

Hardware Requirements	**Software Requirements**
PC With following Configuration 1. Intel Core i3/i5/i7	1. ETL tools 2. Warehouse tools 3. Java/Python compiler

Processor 2. 4 GB RAM 3. 500 GB Harddisk	

Prerequisite: DBMS.

Detailed syllabus:

Module No.	Detailed Content	Hours	CO Mapping
I	a) Implementation of any Query optimizer (Java/Python) b) Assignments for query evaluation path expressions.	4	LO 2
II	c) Simulation of Concurrency Control Algorithm, Recovery Algorithm (Java/Python)	4	LO1
III	a) Design of a distributed database for a real life application - Fragmentation, Query Processing b) Simulation of Recovery methods.	4	LO 4
IV	**Advanced Database Models** Case study based assignments for Temporal, Mobile or Spatial databases	4	LO 3
V	**Data Warehouse Construction** a) Real life Problem to be defined for Warehouse Design b) Construction of star schema c) ETL Operations.	6	LO 4
VI	**OLAP Exercise** a) Construction of Cubes b) OLAP Operations, OLAP Queries	4	LO 6

Text Books:

1. Elmasri and Navathe, “Fundamentals of Database Systems”, 6th Edition, PEARSON Education.
2. Theraja Reema, “Data Warehousing”, Oxford University Press, 2009.
3. Data Warehousing, Data Mining, & OLAP by Alex Berson McGraw Hill.

References:

1. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom “Database System Implementation”, Pearson Ltd. 1/ e
2. Thomas M. Connolly Carolyn Begg, Database Systems : A Practical Approach to Design, Implementation and Management, 4/e Pearson Ltd

3. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling", 3rd Edition. Wiley India.

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL504	IOT (Mini Project) Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL504	IOT (Mini Project) Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try to:

1. Address the real world problems and find the required solution.
2. Design the problem solution as per the requirement analysis done.
3. Study the basic concepts of programming/ hardware/ emulator for Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc.
4. Fabricate and implement the mini project intended solution for project based learning.
5. Build and test the mini project successfully.
6. Improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.
4. Demonstrate and build the project successfully by hardware requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Guidelines

1. The mini project work is to be conducted by a group of three students

2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.

3. The students may do survey for different application using Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc topics for the mini project.

4. Each group will identify the Hardware and software requirement for their mini project problem statement.

5. Prototype/Design your own circuit board using Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc.

6. Installation, configure and manage your Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc board/kit.

7. Work with operating system and do coding to for input devices on board.

8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.

9. Create and interface using Web to publish or remotely access the data on Internet.

10. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.

11. Each group may present their work in various project competitions and paper presentations.

12. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Massimo Banzi,"Getting Started with Arduino",O'reilly, 2nd edition
2. Simon Monk," Raspberry Pi Cookbok", O'reilly
3. Raspberry Pi User Guide

References:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL505	Business Communication and Ethics	2	2*	--	--	2	--	2

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL505	Business Communication and Ethics	--	--	--	--	50	--	--	50

***** Batch wise practical's

Pre-requisite

- Communication Skills

Course Objective: Students will try:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Course Outcomes: Students will learn to:

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module	Detailed Contents	Hrs.
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**08**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	**Employment Skills**	**06**

6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		26

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

1. **Term Work:**
2. Term work shall consist of all assignments from the list. The distribution of marks for term
3. work shall be as follows:
4. Book Report……..(10) Marks
5. Assignments …… (10) Marks
6. Project Report Presentation…….. (15) Marks
7. Group Discussion…… (10) Marks
8. Attendance ……(05) Marks
9. **TOTAL: ……(50) Marks**

The final certification and acceptance of term work ensures the satisfactory performance of work assigned and minimum passing in the term work.

References

1. Fred Luthans, *"Organizational Behavior"*, McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business"*, McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication"*, McGraw Hill

4. Wallace and Masters, *"Personal Development for Life and Work"*, Thomson Learning, 12th edition
5. Heta Murphy, *"Effective Business Communication"*, Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing"*, Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development"*, Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5011	Advanced Data Structures & Analysis of Algorithms	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5011	Advanced Data Structures & Analysis of Algorithms	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To learn mathematical background for analysis of algorithm
2. To learn various advanced data structures.
3. To understand the concept of designing an algorithm.
4. To learn dynamic programming and greedy method.
5. To understand the concept of pattern matching
6. To learn advanced tree and graph applications.

Course Outcomes:

1. Students will be able to choose appropriate advanced data structure for given problem.
2. Students will be able to calculate complexity.
3. Students will be able to select appropriate design techniques to solve real world problems.
4. Students will able to apply the dynamic programming technique to solve the problems.
5. Students will be able to apply the greedy programming technique to solve the problems.
6. Students will be able to select a proper pattern matching algorithm for given problem.

Prerequisite: Knowledge Any Programming Language, Data structures and Analysis

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
	Prerequisite	Data structures and analysis	02	--
I	Introduction	Introduction • Introduction to advanced data structures: • Introduction/Fundamentals of the analysis of algorithms o Recurrences: ▪ The substitution method ▪ Recursive tree method ▪ Masters method o Probabilistic analysis o Amortized analysis o Randomized algorithms o Mathematical aspects and analysis of algorithms	10	CO1 CO2
II	Advanced Data Structures	• Introduction • AVL tree • Huffman algorithm • B/B+ tree • 2-3 tree operations • Red-Black Trees • tries • Heap operations • Implementation of priority queue using heap • Topological sort Analysis of All problems	11	CO1 CO2 CO3
III	Divide and Conquer	• Introduction • Binary search • Finding the minimum and maximum • Merge sort • Quick sort • Strassen's matrix multiplication Analysis of All problems	7	CO2 CO3
IV	Greedy algorithms	• Introduction • Knapsack problem • Job sequencing with deadlines • Minimum cost spanning trees	8	CO2 CO3

		○ Kruskal's algorithm ○ Prim's algorithm • Optimal storage on tapes • Optimal merge pattern • Subset cover problem • Container loading problem Analysis of All problems		CO5
V	Dynamic algorithms And NP-Hard and NP-Complete	Introduction Dynamic algorithms • All pair shortest path • 0/1 knapsack • Travelling salesman problem • Coin Changing Problem • Matrix Chain Multiplication • Flow shop scheduling • Optimal binary search tree (OBST) • Analysis of All problems • Introduction to NP-Hard And NP-Complete Problems	8	CO2 CO3 CO4
VI	String Matching	• introduction • The naïve string matching algorithm • Rabin Karp algorithm • Knuth-Morris-Pratt algorithm (KMP) • Longest common subsequence(LCS) • Analysis of All problems • Genetic algorithms	6	CO2 CO3 CO6

Text Books:

1. Introduction to ALGORITHMS, Cormen, Leiserson, Rivest, Stein, PHI.
2. Algorithms: Design and Analysis, Harsh Bhasin, OXFORD.
3. Fundamentals of Computer Algorithms, Horowitz, Sahani, Rajsekaran, Universities Press.
4. C and Data structures, Deshpande, Kakde, Dreamtech Press.

Reference Books:

1. Data Structures and Algorithms in C++, Goodritch, Tamassia, Mount, WILEY.
2. Data Structures using C, Reema Thareja, OXFORD.
3. Data Structures and Algorithm Analysis in C, Mark A. Weiss, Pearson.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5012	Image Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5012	Image Processing	20	20	20	80	--	--	100

Course Objectives: The course will help the students to get familiar with

1. Fundamental concepts of a digital image processing system.
2. Concepts of image enhancement techniques.
3. Various Image Transforms.
4. Compression techniques and Morphological concepts
5. Various segmentation techniques, and object descriptors.
6. Color models and various applications of image processing.

Course Outcomes: Students should be able to:

1. Remember the fundamental concepts of image processing.
2. Explain different Image enhancement techniques
3. Understand and review image transforms
4. Analyze the basic algorithms used for image processing &image compression with morphological image processing.
5. Contrast Image Segmentation and Representation
6. Design & Synthesize Color image processing and its real world applications.

Prerequisite: Mathematics and Statistics.

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	As images are two dimensional signals, the single dimensional Digital Signal Processing fundamentals.	02	

I	Introduction to digital image processing system	Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships between Pixels.	07	CO 1
II	Image enhancement	Intensity Transformations and Spatial Filtering, Histogram processing, Filtering in Frequency Domain	09	CO 2
III	Image transforms	Discrete Fourier transform - Properties of two dimensional DFT, DCT, DST, Walsh, Hadamard, Haar Transform and their properties.	07	CO 3
IV	Image compression and morphological image processing	Fundamentals of compression, Basic compression Methods, Huffman Coding, Arithmetic Coding , LZW Coding , Run-Length Coding , Symbol-Based Coding, Bit-Plane Coding, Block Transform Coding , Predictive Coding. Image morphology, Opening & Closing, Hit or Miss Transform, Basic Morphological Algorithms	11	CO 4
V	Image segmentation and representation	The detection of discontinuities - Point, Line and Edge detections , Hough Transform, Thresholding Region based segmentation Chain codes, Polygon approximation, Shape numbers, Fourier descriptors, statistical Moments.	08	CO 5

VI	Color Image Processing and Applications	Color Fundamentals and Models, Pseudocolor Image Processing, Smoothing and Sharpening, Image Segmentation Based on Color. Biometric Authentication, Digital watermarking, Content Base Image Retrieval. Vector quantization	08	CO 6

Text Books:

1. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition - Wesley Publishing Company, New Delhi, Third Edition, 2007.
2. William K. Pratt, "Digital Image Processing", John Wiley, NJ, Fourth Edition 2007.

Reference Books:

1. Sid Ahmed M.A., "Image Processing Theory, Algorithm and Architectures", McGraw-Hill, 1995.
2. Kenneth R Castleman, "Digital Image Processing", Prentice Hall, New Delhi, 1996.
3. Anil.K.Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt Ltd., New Delhi, 1995.
4. S. Sridhar, " Digital Image Processing", second Edition, Oxford university press, New Delhi, 2016.
5. S. Jayaraman, S. Esakkirajan, T. Veerakumar " Digital Image Processing", McGraw-Hill, 2016

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5013	E-Commerce & E-Business	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5013	E-Commerce	20	20	20	80	--	--	100

Course Objectives: Students will try to :

1. Understand concept of Ecommerce and its types.
2. Be familiarized with technologies for Ecommerce.
3. Understand different types of Online Payment systems.
4. Understand Selling and marketing on web.
5. Be familiarized with concept of E-business and E-business Models.
6. Understand various E-business Strategies.

Course Outcomes: Students will be able to:

1. Define and differentiate various types of E-commerce.
2. Describe Hardware and Software Technologies for E-commerce.
3. Explain payment systems for E -commerce.
4. Describe the process of Selling and Marketing on web.
5. Define and Describe E-business and its Models.
6. Discuss various E-business Strategies.

Prerequisite: Internet Technologies, Internet Security, Middleware technologies, web services

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Internet Technologies, Internet Security, Middleware technologies, web services	02	
I	Introduction to E	E –commerce :Definition of e commerce , different types of E-commerce ,Examples	04	CO1

	–commerce	of E- commerce, E-commerce trade cycle , advantages and disadvantages of E-commerce , Traditional commerce Vs E - commerce		
II	Overview of Hardware and Software Technologies for Ecommerce	Overview of Client side programming (Dream weaver , Front page) Hardware and , Server side Programming (PHP) , Database Software connectivity , session tracking, middleware technologies for ecommerce perspective and security aspects with respect to e commerce, integration of web services	08	CO2
III	Payment System for Ecommerce	Traditional payment model , Characteristics of payment, Online Payment Basics, Payment Cards, Electronic Cash, Electronic Wallets, Stored-Value Cards, SET Protocol for credit card payment, Internet Technologies and the Banking Industry	10	CO3
IV	Selling and Marketing on Web	Selling on the Web: Revenue Models and Building a Web Presence: Revenue Models, Revenue Models in Transition, Revenue Strategy Issues, Creating an Effective Web Presence, Web Site Usability, Connecting with Customers Marketing on the Web: Web Marketing Strategies, Communicating with Different Market Segments, Beyond Market Segmentation: Customer Behavior and Relationship Intensity, Advertising on the Web, E-Mail Marketing, Technology-Enabled Customer Relationship Management, Creating and Maintaining Brands on the Web Online Auctions, Virtual Communities, and Web Portals	10	CO4
V	E business :- Introduction to e business and Developing E-business models	Definition of e- business , Characteristics , elements of e business , e business roles , Impact of e business , challenges of e business , difference between e business and e commerce , E-business structure, Evolution of E –business and stages , E – business models , Characteristics of Internet based software and e business solutions	10	CO5
VI	E business strategies	Strategic planning process, SCM , CRM , ERP , procurement	08	CO6

Text Books:

1 E -Commerce Fundamentals and application (Henry Chan) Wiley publication
2. Electronics Commerce (Gary Schneider) Thomson Course technology
3.E –Business , Parag Kulkarni , Sunita Jahirabadkar, Pradip Chande , Oxford Higher Education , Oxford University Press
4. E –business and E –commerce Management , Dave Chaffey , Pearson , 3rd edition
5. E commerce by Laudon

References:

1. E-Commerce Strategies, Technology and applications (David Whitley) Tata McGrawHill
2. Introduction to E-commerce Elias Awad

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5014	IT Enabled Services	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5014	IT Enabled Services	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand importance of IT enabled services and challenges for the same.
2. To understand strategic IT planning for industries.
3. To develop enterprise IT architecture for Information technology.
4. To encourage the use of Information Technology so as to enable students to improve their skills, knowledge and job prospects and enable them to obtain employment in sunrise industries.
5. To develop the ability to integrate various resources for optimization in the industry as well as for strategic utilization of IT enabled services and functions.
6. To develop competence in global sourcing: strategy and management to gain a perspective on the global services sourcing landscape: past, present, and future.

Course Outcomes: Students will be able to:

1. Describe the importance of IT enabled services and challenges.
2. Identify strategic IT planning for software development.
3. Recognize enterprise IT architecture for Information technology.
4. Use of Information Technology so as to enable them for job in sunrise industries.
5. Illustrate various IT web services for betterment of knowledge.
6. Use their skills to find out various current IT trends in ITES.

Prerequisite: Internet Programming.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Information Technology and Project Management, Web Engineering and Technology.	02	
I	Business strategy: challenges and opportunities for IT	Business Strategy: Challenges and Opportunities in the Globalized, Interconnected, Convergent World, Establish Principles before Practice, IT Strategy, Application Strategy, Technology Strategy for IT, IT Management Strategy, Developing IT Strategy for Competitive Advantage, Stages of IT Strategy Development and Implementation, Challenges of IT and Business Strategy Alignment, Inhibitors of Business and IT Strategy Alignment, Three-D Framework for Business and IT Strategy Alignment.	09	CO1
II	Strategic IT planning	Business Implications for IT Strategic and Planning, Strategic IT Planning Motivations, SITP Process: Prevalent Planning Approaches, Difficulties in Developing and Executing SITP, Best Practices for Achieving Good SITP, SITP Approaches-Prevalent Researches.	09	CO2
III	Enterprise IT architecture	Defining EITA, Contents of a Typical Enterprise IT Architecture, Standard for Enterprise IT Architecture, Technology Management strategy Framework, Prevalent Technology Reference Architectures Framework and Standards, Program Management, Benefits of PMO, Desired Qualities of a Program Office Manager, Maturity of PMO, Implementation of PMO Strategy, Measuring PMO Performance, Success Factors for PMO, Project Scope Management, PMO Dashboard and Reporting.	08	CO3

IV	IT service management strategy	Information Technology Infrastructure Library (ITIL), ITIL Overview, ITIL Service Support Processes, Incident Management, Problem Management, Service Delivery, Service Level Management, Financial Management, Capacity Management, IT Service Continuity Management (ITSCM), Availability Management, Imperatives for Outsourcing, IT Management Layers, Variants of Outsourcing, Business Process Outsourcing, In sourcing.	08	CO4
V	IT enabled web services	Overview of basic features of PHP: arrays, functions and state management, working with PHP forms, More advanced PHP, OOP's concept in PHP, Portable database supported with different, exception handling, concepts of UDDI, WSDL, SOAP.	08	CO5
VI	Current trends in ITES	Current Employment in the IT and ITES industry: Newly emerging area and requirement of IT enabled service sector. Industry Oriented Human Resource Requirement: Outlook of the IT and ITES Industry. Barriers to Trade in ITES Role of International Bodies (WTO & UNCTAD) in facilitating Trade in ITEST/ITES, experiences and Case studies of ITES-call centers, ERP, google.	08	CO6

Text Books:

1. Sanjiva Shankar Dubey, " IT strategy and Management", PHI.
2. K. Venkatesh, " Marketing of Information Technology",TMH.
3. Steve Suehring, Timconverse, Joyoe Park , "PHP 6 and MySQL Bible", Wiley.

References:

1. Shiro Uesugi, “IT Enabled Services”, Springer; 2013 edition, 2013.
2. Sanjiva Shankar Dubey, “IT Services Business Management: Concepts, Processes and Practices”, PHI, 2012.
3. Nikhil Treebhoohu, “Promoting IT Enabled Services”, Addison-Wesley, 2013.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITDLO5015	Computer Graphics & Virtual Reality	04	--	---	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5015	Computer Graphics & Virtual Reality	20	20	20	80	----	--	100

Course Objectives: Students will try:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To learn the basic principles of 3-dimensional computer graphics.
3. Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
4. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
5. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.
6. To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Course Outcomes: Students will be able to:

1. To list the basic concepts used in computer graphics.
2. To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
3. To describe the importance of viewing and projections.
4. To define the fundamentals of animation, virtual reality and its related technologies.
5. To understand a typical graphics pipeline
6. To design an application with the principles of virtual reality

Prerequisite: Basic Mathematics

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge of Mathematics	2	
I.	Introduction to Computer graphics and Output primitives	**Introduction**: Display Devices, Bitmap and Vector based graphics, Overview of Coordinate System. **Scan Conversion** of**:** point, line using Digital differential analyzer & Bresenham's algorithm, circle using midpoint approach, **Curve Generation**: Bezier and B-Spline curves. **Introduction to fractals**: generation procedure, classification, dimension and Koch Curve.	7	CO1
II.	Area Filling, Transformations (2D and 3D)	**Area filling**: Inside/Outside Test, Scan line Polygon Fill Algorithm, Boundary Fill and Flood Fill algorithm. **Basic Geometrical 2D Transformations:** Translation, Rotation, Scaling, Reflection, Shear, their homogeneous Matrix representation and Composite transformation. **Three Dimensional transformations:** Translation, Scaling, Rotations, Composite.	8	CO1 CO2
III.	Viewing (2D and 3D) Projection and Clipping	**Viewing**: Introduction, Viewing Pipeline, View Coordinate reference frame, Window to viewport transformation. **Three-Dimensional Viewing:** 3D Pipeline, Viewing transformation, **Projections**: Parallel (Oblique and orthographic), Perspective (one Point) **Clipping**: Point clipping, Line clipping**:** Cohen Sutherland Algorithm, Liang Barsky algorithms, Polygon clipping: Sutherland Hodgeman polygon clipping and Weiler Atherton. Text Clipping.	10	CO1 CO2 CO3

IV.	Introduction To Animation	**Animation**: Key Frame Animation, Animation Sequence, Motion Control Methods, **Morphing**, **Warping**- Mesh Warping.	4	CO1 CO2 CO4 CO5
V.	Introduction to Virtual Reality	**Virtual Reality:** Basic Concepts, Overview and perspective on virtual reality, Human sensation and perception. Classical Components of VR System, Types of VR Systems, Three-Dimensional Position Trackers, Navigation and Manipulation Interfaces, Gesture Interfaces, Input Devices, Graphical Display, Sound displays, and Haptic Feedback. Graphical Rendering Pipeline, Haptic Rendering Pipeline, Open GL rendering pipeline. **Applications** of Virtual Reality.	9	CO1 CO2 CO4 CO6
VI.	VR Modeling and Programming	**Geometric Modeling**: Virtual Object Shape, Object Visual Appearance. **Kinematics Modeling**: Object Position, Transformation Invariants, Object Hierarchies, **Physical Modeling**: Collision Detection, Surface Deformation, Force Computation. **Behavior Modeling**. Programming through **VRML/X3D**: Defining and Using Nodes and Shapes, VRML Browsers, **Java 3D, OpenCV** for augmented reality	12	CO1 CO2 CO4 CO6

Text Books

1 Donald Hearn and M. Pauline Baker, “Computer Graphics”, Pearson Education.
2 R. K Maurya, “Computer Graphics with Virtual Reality”, Wiley India.

Reference Books

1. Grigore Burdea, Philippe Coiffet, “Virtual Reality Technology”, Wiley.
2. Steven Harrington, “Computer Graphics”, McGraw Hill.
3. Rogers, “Procedural Elements of Computer Graphics”, Tata McGraw Hill.
4. Vince, “Virtual Reality Systems”, Pearson Education.
5. F.S. Hill, Stephen M. Kelley , “Computer Graphics using Open GL” Prentice Hall
6. Samyak Datta , “Learning OpenCV 3 Application Development”, Packt

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

T. E. Information Technology (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC601	Software Engineering with Project Management	4	-	-	4	-	-	4
ITC602	Data Mining and Business Intelligence	4	-	-	4	-	-	4
ITC603	Cloud Computing & Services	4	-	-	4	-	-	4
ITC604	Wireless Networks	4	-	-	4	-	-	4
ITDLO-II	Department Level Optional Course -II	4	-	-	4	-	-	4
ITL601	Software Design Lab	-	2	-	-	1	-	1
ITL602	Business Intelligence Lab	-	2	-	-	1	-	1
ITL603	Cloud Service Design Lab	-	2	-	-	1	-	1
ITL604	Sensor Network Lab	-	2	-	-	1	-	1
ITM605	Mini-project	-	4	-	-	2	-	2
	Total	**20**	**12**	-	**20**	**6**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC601	Software Engineering with Project Management	20	20	20	80	3	-	-	-	100
ITC602	Data Mining and Business Intelligence	20	20	20	80	3	-	-	-	100
ITC603	Cloud Computing & Services	20	20	20	80	3	-	-	-	100
ITC604	Wireless Networks	20	20	20	80	3	-	-	-	100
ITDLO-II	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
ITL601	Software Design Lab	-	-	-	-	-	25	25	--	50
ITL602	Business Intelligence Lab	-	-	-	-	-	25	25	--	50
ITL603	Cloud Service Design Lab	-	-	-	-	-	25	25	--	50
ITL604	Sensor Network Lab	-	-	-	-	-	25	25	--	50
ITM605	Mini-Project	-	-	-	-	-	25	25	--	50
Total		100	100	100	400	-	125	125	--	750

 # Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VI. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Subject Code	Department Level Optional Course (DLO)
Semester VI	
ITDLO6021	Advance Internet Programming
ITDLO6022	Software Architecture
ITDLO6023	Digital Forensics
ITDLO6024	Multimedia Systems
ITDLO6025	Green IT

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC601	Software Engineering with Project Management	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC601	Software Engineering with Project Management	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand the nature of software development and software life cycle process models, agile software development, SCRUM and other agile practices.
2. To Explain methods of capturing, specifying, visualizing and analyzing software requirements.
3. To understand concepts and principles of software design and user-centric approach and principles of effective user interfaces.
4. To know basics of testing and understanding concept of software quality assurance and software configuration management process.
5. To understand need of project management and project management life cycle.
6. To understand project scheduling concept and risk management associated to various type of projects.

Course Outcomes: Students will be able to:

1. Define various software application domains and remember different process model used in software development.
2. Explain needs for software specifications also they can classify different types of software requirements and their gathering techniques.
3. Convert the requirements model into the design model and demonstrate use of software and user-interface design principles.
4. Distinguish among SCM and SQA and can classify different testing strategies and tactics and compare them.
5. Justify role of SDLC in Software Project Development and they can evaluate importance of Software Engineering in PLC.
6. Generate project schedule and can construct, design and develop network diagram for different type of Projects. They can also organize different activities of project as per Risk impact factor.

Prerequisite: Programming and Networking.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Nature of Software, Software Definition, Software Characteristics, Software Application Domains	02	
I	The Software Process	Generic view of Process, Prescriptive Models: Waterfall Model, Incremental-RAD Model, Evolutionary Process Model-Prototyping, Spiral and Concurrent Development Model, Specialized Models: Component based, Aspect Oriented Development, Agile Methodology, Scrum and Extreme Programming	07	CO1
II	Requirements Engineering and Cost Estimation	Requirement, Types of Requirements, Requirement gathering, Requirement Engineering Task, Identifying Stakeholders, Multiple viewpoints, SRS (Software Requirement Specification) Project Estimation, LOC based, FP based and Use case based estimation.	07	CO1 CO2
III	Analysis and Design Engineering	Introduction of Analysis elements, Scenario based, Flow based, behavior and class based Design Concepts and Principles, Architecture Design, Component Level Design, System Level Design, User Interface Design.	09	CO1 CO2 CO3
IV	Quality & Configuration Management	Need for Testing, Testing Tactics, Testing strategies, McCall's Quality Factor, Software Configuration Management, SCM Process	07	CO4
V	IT Project Management	Introduction, 4 P's, W5HH Principle, Need for Project Management, Project Life cycle and ITPM, Project Feasibility, RFP, PMBOK Knowledge areas, Business Case, Project Planning, Project Charter and Project Scope.	10	CO5

VI	Project Scheduling and Risk Management	WBS, Developing the Project Schedule, Network Diagrams (AON, AOA), CPM and PERT, Gantt Chart, Risk Identification, Risk Projection and RMMM	10	CO1 CO2 CO3 CO4 CO6

Text Books:

1. Roger S Pressman "Software Engineering : A Practitioner's Approach" 7th Edition Mcgraw-Hill ISBN:0073375977
2. Jack T. Marchewka, "Information Technology Project Management" 4th Edition ,Wiley India

References:

1. "Software Engineering : A Precise Approach" Pankaj Jalote , Wiley India
2. Ian Sommerville " Software Engineering" 9th edition Pearson Education SBN-13: 978-0- 13-703515-1, ISBN-10: 0-13-703515-2
3. John M. Nicholas, Project Management for Business and Technology, 3rd edition, Pearson Education.
4. Software Project management by Bob Hughes, Mike Cotterell , Rajib Mall

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC602	Data Mining and Business Intelligence	04		--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC602	Data Mining and Business Intelligence	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
2. To enable students to effectively identify sources of data and process it for data mining
3. To make students well versed in all data mining algorithms, methods of evaluation.
4. To impart knowledge of tools used for data mining
5. To provide knowledge on how to gather and analyze large sets of data to gain useful business understanding.
6. To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.

Course Outcomes: Student will be able to:

1. Demonstrate an understanding of the importance of data mining and the principles of business intelligence
2. Organize and Prepare the data needed for data mining using pre preprocessing techniques
3. Perform exploratory analysis of the data to be used for mining.
4. Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.
5. Define and apply metrics to measure the performance of various data mining algorithms.
6. Apply BI to solve practical problems : Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.

Prerequisite: Database Management System, Advanced Data Management Technology.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Knowledge of databases, and Date warehousing, OLAP	02	--
I	Introduction to Data Mining	What is Data Mining; Kind of patterns to be mined; Technologies used; Major issues in Data Mining	03	CO1
II	Data Exploration and Data Preprocessing	Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity. Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	09	CO2 CO3
III	Classification	Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes‟ Classifier. Prediction: Structure of regression models; Simple linear regression, Multiple linear regression. Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation.	09	CO4 CO5
IV	Clustering	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K-Mediods; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based.	10	CO4 CO5
V	Frequent Pattern	Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and	10	CO4

	Mining	Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, lift, ; Introduction to Constraint-Based Association Mining.		CO5
VI	Business Intelligence	What is BI? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance CRM etc.	09	CO6

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education.
3. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis ,Wiley India Publications.
4. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 2nd Edition, Wiley India.

References:

1. Michael Berry and Gordon Linoff “Data Mining Techniques”, 2nd Edition Wiley Publications.
2. Michael Berry and Gordon Linoff “Mastering Data Mining- Art & science of CRM”, Wiley Student Edition.
3. Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC603	Cloud Computing & Services	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC603	Cloud Computing & Services	20	20	20	80	--	--	100

Course Objectives: Students will try to learn:

1. Basics of cloud computing.
2. Key concepts of virtualization.
3. Different Cloud Computing services
4. Cloud Implementation, Programming and Mobile cloud computing
5. Key components of Amazon Web Services
6. Cloud Backup and solutions

Course Outcomes: Students should be able to:

1. Define Cloud Computing and memorize the different Cloud service and deployment models
2. Describe importance of virtualization along with their technologies.
3. Use and Examine different cloud computing services
4. Analyze the components of open stack & Google Cloud platform and understand Mobile Cloud Computing
5. Describe the key components of Amazon web Service
6. Design & develop backup strategies for cloud data based on features.

Prerequisite Subjects: Computer Network, Operating System

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	OSI Layers, Basics of OS.	02	--
I	Introduction	Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud	06	CO1

		Computing, Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing.		
II	Virtualization	Virtualization: Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors, Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU, Memory and I/O Devices , Virtualization and Cloud Computing, Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV	10	CO2
III	Cloud Computing Services	Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, and Infrastructure as a service. Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.	09	CO1 CO2 CO3
IV	Cloud Implementation, Programming and Mobile Cloud Computing	Open Stack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations. Programming support for Google apps engine-GFS, Bigtables, Chubby, Google APIs. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile	09	CO1 CO2 CO3 CO4

		cloud computing		
V	Exploring the Components of Amazon Web Services	AWS cloud computing Platform, a) Elastic Compute Cloud(EC2): Compute Basics, Instance types, Life cycle of instances. b) Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3. c) Elastic Block Storage (EBS):Basics and Types of EBS Volumes d)Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP), Elastic Network Interfaces (ENIs) & Security groups & ACL. e) Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling.	11	CO1 CO2 CO3 CO4 CO5
VI	Cloud Backup & Solutions	Cloud Backup Solutions and their features, Cloud data management interface (CDMI), Cloud Storage gateways (CSG), Comparison between different cloud platforms: Amazon web services & Open stack (Based on Type of deployment, Services supported and their components).	05	CO1 CO2 CO3 CO4 CO5 CO6

Text Books:

1. Barrie Sosinsky ,"Cloud Computing Bible",Wiley Publication.
2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, "Cloud Computing Black Book", Dreamtech Press.
3. Joe Baron et.al ,"AWS certified solution Architect", Sybex publication.
4. Mastering Cloud Computing, Rajkumar Buyya, MGH publication

Reference Books:

1. Thomas Erl,Robert Cope,Amin naserpour,"Cloud Computing Design Patterns",Pearson Publication.
2. Judith Hurwitz ,"Cloud Computing for Dummies" , Wiley Publication.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC604	Wireless Network	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC604	Wireless Network	20	20	20	80	--	--	100

Course Objectives: Students will try to:

1 Understand the fundamentals of wireless networks.
2 Learn and analyze the different wireless technologies.
3 Evaluate Ad-hoc networks and wireless sensor networks.
4 Understand and evaluate emerging wireless technologies and standards
5 Understand design considerations for wireless networks
6 Learn and analyze and evaluate the security threats and related security standards

Course Outcomes: Students will be able to:

1. Explain the basic concepts of wireless network and wireless generations.
2. Demonstrate the different wireless technologies such as CDMA, GSM, GPRS etc
3. Appraise the importance of Ad-hoc networks such as MANET and VANET and Wireless Sensor networks
4. Describe and judge the emerging wireless technologies standards such as WLL, WLAN, WPAN, WMAN.
5. Explain the design considerations for deploying the wireless network infrastructure.
6. Differentiate and support the security measures, standards. Services and layer wise security considerations.

Prerequisite: Computer Networks.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Modulation and Demodulation Techniques, PSTN	02	
I	Fundamentals Wireless Communication	Fundamentals of Wireless Communication, Advantages, limitations and application, wireless media, Infrared Modulation Techniques, DSSS and FHSS, Frequency Spectrum: Radio and Infrared; Wireless generations: 1G: Cellular,2G: Mobile Radio,3G: UMTS- Security related Encryption Algorithm,4G	07	CO1
II	Evolution of Wireless Technologies	Multiple Access Technique: TDMA, FDMA, CSMA, CDMA Wireless Technologies: GSM, GPRS, EDGE,CDMA,LTE, UMTS	10	CO1 CO2
III	Types of Wireless Networks	Ad-hoc: MANET & VANET, Application, Advantage and limitations; Wireless Sensor Network: Application, advantages and limitations	09	CO1 CO3
IV	Emerging Wireless Technologies and standards	WLL , WLAN- 802.11 (Wi-Fi), WPAN- 802.15.1/3/4 (Bluetooth, Zigbee), WMAN-802.16a (Wi-max) , Wi-max and LTE /3GPP comparison, Mi-fi, Ly-fi,	10	CO1 CO2 CO4
V	Wireless Network Design Considerations	Wireless technology, Cisco Unified Wireless Network, Designing Wireless Networks with Lightweight Access Points and Wireless LAN Controllers	07	CO1 CO2 CO3 CO4 CO5
VI	Wireless Network Security	The need, attacks, security serviced, WEP, Mobile IP, VPN(PPTP, LLTP, IPSec), Network Layer Security, Transport Layer Security, Email Security: PGP, S/ MIME, Internet Firewalls for Trusted System	07	CO1 CO2 CO3 CO6

Text Books:

1. Cellular Communications: A Comprehensive and Pratical Guide, Nishith Tripathi, Jeffery H Reed, Wiley
2. Wireless Mobile Internet Security, 2nd Edition, Man, Young Rhee, Wiley- IEEE press
3. Designing for Cisco Internetwork Solutions (DESGN), 2nd Edition, CCDA, Diane Teare, cisco Press.

References:

1. Introduction to Digital mobile communication, 2nd Edition, Yoshihiko Akaiwa
2."Wireless Communications and networks", William Stallings, Pearson / Prentice Hall
3. Wireless communication and networking, Vijay Garg

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL601	Software Design Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL601	Software Design Lab	--	--	--	--	25	--	25	50

Course Objectives: Students will try to:

1 Learn basic concepts of UML.
2 Master the vocabulary, rules, and idioms of the UML and learn how to model it effectively.
3 Understand how to apply the UML to solve a number of common modeling problems.
4 Model the systems, from concept to executable artifact, using object-oriented techniques.
5 Apply the knowledge of Software engineering and project management.
6 Understand the software development process using tool.

Course Outcomes: Students will be able to:

1. Sketch a Modeling with UML.
2. Deploy Structural Modeling.
3. Deploy Behavioral Modeling.
4. Deploy Architectural Modeling.
5. Examine estimation about schedule and cost for project development.
6. Select project development tool.

Prerequisite: Object oriented Concept, Java programming language.

Requirement:-

Hardware	**Software**
PC i3 or above.	IBM Rational Rose Modeler, Dia, StarUML (Any One) Orange Scrum, Xampp , GitHub

Guidelines

1. Students should take one case study as a mini project work which is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must be able to identify Object oriented Technologies, Basic expression of Classes, Attributes and operations.
4. Students must develop a Conceptual Model of the UML for above case study.
5. Students should define Classes, Relationships, Class Diagrams, Advanced Classes and Relationship, Object Diagrams for above case study.
6. Students should define Use Cases, Use case Diagrams, Activity Diagrams, Interaction Diagrams, State Chart Diagrams for above case study.
7. Students should define Components, Deployment, Collaborations, Component Diagrams, Deployment Diagrams for above case study
8. Students should define SRS, WBS, Network Diagram, Gantt Chart, Cost Estimation Techniques
9. Demonstration it using Scrum Tool
10. Each group may present their work in various project competitions and paper presentations.
11. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. "The Unified Modeling Language User Guide" by Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Publication,ISBN 978-81-7758-372-4
2. Jack T. Marchewka, Information Technology Project Management, 4th edition, Wiley India, 2009.

References:

1. UML – Tutorial "www.tutorialspoints.com/uml/"
2. "An Introduction to Object-Oriented Analysis: Objects and UML in plain English" by Davis William Brown, Wiley, Second Edition
3. "Fundamentals of Object-Oriented Design in UML", Meilir Page-Jones, Pearson Education
4. UML in 24 Hours
5. UML Basics— an Introduction to the Unified Modeling Language – IBM "www.ibm.com › Learn › Rational"

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Case Study and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL602	Business Intelligence lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL602	Business Intelligence Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
2. To enable students to effectively identify sources of data and process it for data mining
3. To make students well versed in all data mining algorithms, methods, and tools.
4. To learn how to gather and analyze large sets of data to gain useful business understanding.
5. To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.
6. To identify and compare the performance of business.

Lab Outcomes: Students should be able to:

1. Identify sources of Data for mining and perform data exploration
2. Organize and prepare the data needed for data mining algorithms in terms of attributes and class inputs, training, validating, and testing files.
3. Implement the appropriate data mining methods like classification, clustering or association mining on large data sets using open source tools like WEKA
4. Implement various data mining algorithms from scratch using languages like Python/ Java etc.
5. Evaluate and compare performance of some available BI packages
6. Apply BI to solve practical problems : Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.

Prerequisite: Object oriented Concept, Java programming language.

Requirement:-

Hardware	Software
PC i3 or above.	Open source data mining and BI tools like WEKA, Rapid Miner, Pentaho.

Detailed syllabus:

Module	Detailed Content	Hours	LO Mapping
1 & II	2 tutorials a) Solving exercises in Data Exploration b) Solving exercises in Data preprocessing	04	LO 1 LO 2
III	Using open source tools Implement a) Classifiers b) Clustering Algorithms c) Association Mining Algorithms	06	LO 3
IV	a) Implementation of any one classifier using languages like JAVA/ python/R b) Implementation of any one clustering algorithm using languages like JAVA/ python c) Implementation of any one association mining algorithm using languages like JAVA/ python	06	LO 4
V	Detailed case study of any one BI tool (open source tools like Pentaho can be used) (paper Assignment)	04	LO 5
VI	**Business Intelligence Mini Project**: Each group assigned one new case study for this; A BI report must be prepared outlining the following steps: a)Problem definition, Identifying which data mining task is needed b) Identify and use a standard data mining dataset available for the problem. Some links for data mining datasets are: WEKA site, UCI Machine Learning Repository, KDD site, KDD Cup etc. c) Implement the data mining algorithm of choice	06	LO 6

	d) Interpret and visualize the results e) Provide clearly the BI decision that is to be taken as a result of mining.		

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 1st Edition, Wiley India.

References:

1. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education.
2. WEKA, RapidMiner Pentaho resources from the Web.

Term Work:
Term Work shall consist of at least 10 to 12 practical’s based on the below list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL603	Cloud Service Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL603	Cloud Service Design Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students to get familiar with:

1. Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation
2. Concept of On demand Application Delivery like SaaS using Ulteo
3. Open source cloud implementation and administration using Open Stack
4. Various Cloud services provided by Amazon Web Services
5. Programming on Platform as a Service cloud
6. Implementation of Storage as a service using Own Cloud.

Lab Outcomes: Students should be able to:

1. Define & implement Virtualization using different types of Hypervisors
2. Describe steps to perform on demand Application delivery using Ulteo .
3. Examine the installation and configuration of Open stack cloud
4. Analyze and understand the functioning of different components involved in Amazon web services cloud platform.
5. Describe the functioning of Platform as a Service
6. Design & Synthesize Storage as a service using own Cloud

Prerequisite Subjects: Computer Network, Operating System, Java Programming

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
a)Hardware Configuration for server 1.Intel or AMD Multi Core processors (like i3/i5/i7/Quad core/Octa core) with Intel VT-X or AMD-V support	**a) Software Requirements for Server** 1.Server OS for Physical Sever like CentOS /Fedora/Ubuntu/ Redhat Server 2.Pre-configured OpenSSH	1. Internet Connection for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.

2. 6 GB RAM 3. 500 GB Harddisk 4. Gigabit Ethernet (GbE) network interface card (NIC) **b)Hardware Configuration for Cloud Client** PC/Laptop/Smart phone/Thin Client or Any device which has built-in Wifi, Ethernet or data connection facility.	3.Xen Server DVD 4.Ulteo DVD **a) Software Requirements for Clients** 1. JDK 1.8 or higher & .NET Framework 4 2. Netbeans or Eclipse IDEs 3. OpenSSH client or putty 4.Vmware Workstation, 5.Oracle Virtualbox 6. Built-in web browser.	

Suggested List of Experiments

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Virtualization	1. Creating and running virtual machines on Hosted Hypervisors like KVM Type 1 ,Vmware Workstation,Oracle Virtualbox 2. Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV	06	LO1
II	On demand Application Delivery and Virtual Desktop infrastructure	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.	04	LO2
III	Open source cloud implementation and administration	To demonstrate installation and Configuration of Open stack Private cloud.	04	LO3
IV	Amazon Web Services	Like auto scaling, elastic load balancing, virtual private computing & Networking. Security service provided by Amazon web services. Accessing AWS using	06	LO4

		web services API provided by Amazon.		
V	Platform as a Service	To Demonstrate Platform as a Service using Googleapp Engine/IBM BlueMix/tSuru	04	LO5
VI	Storage as a Service	Explore Storage as a service using own Cloud for remote file access using web interfaces. S3 storage and glacier storage and understand the storage LC management provided by AWS.	02	LO6

Text Books:

1. Barrie Sosinsky ,"Cloud Computing Bible",Wiley Publication.
2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr.Deven Shah, "Cloud Computing Black Book", Dreamtech Press.
3. Joe Baron et.al ,"AWS certified solution Architect", Sybex publication.
4. Mastering Cloud Computing, Rajkumar Buyya, MGH publication

Reference Books:

1. Learn to Master Cloud Computing by Star EduSolutions
2. Kai Hwang,"Distributed and Cloud Computing",MK Publication
3. Thomas Erl,Robert Cope,Amin naserpour,"Cloud Computing Design Patterns",Pearson Publication.
4. Judith Hurwitz ,"Cloud Computing for Dummies" , Wiley Publication.

Web Resources:

1. http://fosshelp.blogspot.in
2. https://aws.amazon.com/
3. https://docs.openstack.org/
4. https://owncloud.org/
5. https://appengine.google.com

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the below list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL604	Sensor Network Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of twoTests					
ITL604	Sensor Network Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To learn different types of sensors from Motes families.
2. To design the problem solution as per the requirement analysis done using Motes sensors.
3. To study the basic concepts of programming/sensors/ emulator like cooja etc.
4. To design and implement the mini project intended solution for project based learning.
5. To build and test the mini project successfully.
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.
4. Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Guidelines

1. The mini project work is to be conducted by a group of three students

2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.

3. The students may do survey for different application using different types of sensors for their mini project.

4. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirement for their mini project problem statement.

5. Design your own circuit board using multiple sensors etc.

6. Installation, configure and manage your sensors in such away so that they can communicate with each other.

7. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors.

8. Create and interface using Mobile/Web to publish or remotely access the data on Internet.

9. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.

10. Each group may present their work in various project competitions and paper presentations.

11. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
2. Contiki Cooja User Guide.

References:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga
2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM605	Mini-Project	--	04	--	--	2	--	2

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITM605	Mini-Project	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students

2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.

3. Department has to allocate half day for the project work in VI semester, 1 day in VII semester and 2 day in VIII semester every week.

4. To encourage project based learning in the curriculum students may identify their technical domain area in semester VI and can perform the Mini-project in the VI semester or students may do literature survey

5. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.

6. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.

7. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.

8. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.

9. Teams must analyze all the results obtained by comparing with other standard techniques.

10. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).

11. The team will finally propose a plan for project work to be continued in the final year.

12. Semester VII to carry out the project good quality project and all these project part

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.

2. Each team will prepare a report that will summarize the results of the literature survey and the project proposal. The list of papers surveyed must be clearly documented.

3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.

4. Oral exam will be conduct on the project done by the students.

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Mini Project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO6021	Advance Internet Programming	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6021	Advance Internet Programming	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To get familiar with the concept of Search Engine Basics.
2. To Understand Search Engine Optimization Techniques.
3. To Learn Web Service Essentials.
4. To gain knowledge of Rich Internet Application Technologies.
5. To be familiarized with Web Analytics 2.0
6. To explore Web 3.0 and Semantic web standards.

Course Outcomes: Students will be able to:

1. Determine SEO Objectives and Develop SEO plan prior to Site Development.
2. Explain Search Engine Optimization Techniques and Develop Keyword Generation.
3. Describe different Web Services Standards.
4. Develop Rich Internet Application using proper choice of Framework.
5. Apply multiple quantitative and qualitative methods for web analytics 2.0.
6. Explain Web 3.0 and Semantic web standards

Prerequisite: Basics of Internet Programming – HTML5, CSS3, XML.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to HTML 5 & CSS3 basics, XML basics	02	
I	Search Engine Basics	Search Engine Basics Algorithm based Ranking Systems – Determining Searcher Intent and Delivering Relevant, Fresh Content, Analyzing Ranking Factors, Using Advanced Search Techniques, Vertical Search Techniques, Country Specific search engines. Determining SEO Objective and Finding Your Site's Audience – Setting SEO Goals and Objective Developing SEO plans Prior to Site Development, SEO for Raw traffic ; E-commerce Sales; Mindshare/Branding; Direct Marketing; Reputation Management; Ideological Influence	09	CO1
II	Search Engine Optimization	Getting started SEO: Defining Your Site's Information Architecture, Auditing an Existing Site to identify SEO Problems, Identifying Current Server Statistic Software and Gaining Access – Determining Top competitors, Benchmarking Current Indexing Status, Current Rankings, Benchmarking Current Traffic Source and Volumes, Conduct SEO/Website SWOT analysis. Keyword Generation – Creating Pages – Website Structure- Creating Content-Creating Communities- building Links-Using Google Analytics-Social Media Optimization-Creating Pay-per-click Campaigns- Optimizing PPC Campaigns through Quality Score optimization - Tracking Results and Measuring Success.	09	CO1 CO2
III	Web Services	Web Services: Introduction to Web Services, XML, XSL, XSLT, WSDL, SOAP, UDDI, Transaction, Business Process Execution Language for web Services, WS-Security and web service security specification, WS-Reliable Messaging, WS-Policy, WS-Attachments. REST-ful web services, Resource Oriented Architecture, Comparison of REST, SOA, SOAP.	08	CO1 CO2 CO3
IV	Rich Internet Application	**Introduction to AJAX**, Blogs, Wikis, RSS feeds **Working with Java Script Object Notation (JSON)**, Implement JSON on server side,	08	CO4

		Implementing Security and Accessibility in AJAX Applications: Secure AJAX application, Accessible Rich Internet Applications **Developing RIA using AJAX Techniques:** CSS, HTML, DOM, XMLHTTPRequest, JavaScript, PHP, AJAX as REST Client **Introduction to Open Source Frameworks and CMS for RIA:** Django, Drupal, Joomla introduction and comparison.		
V	Web Analytics 2.0	Introduction to Web Analytics 2.0 1: State of the Analytics Union, State of the Industry, Rethinking Web Analytics: Meet Web Analytics 2.0, Optimal Strategy for Choosing Your Web Analytics Soul Mate. The Awesome World of Clickstream Analysis: Metrics. The Key to Glory: Measuring Success. Failing Faster: Unleashing the Power of Testing and Experimentation.	08	CO4 CO5
VI	Web 3.0 and Semantic Web	**Web 3.0 and Semantic Web**: Challenges, Components, Semantic Web Stack: RDF, RDF Schema (RDFS), Simple Knowledge Organization System (SKOS), SPARQL as RDF query language, N-Triples as a format for storing and transmitting data, Turtle (Terse RDF Triple Language), Web Ontology Language (OWL) a family of knowledge representation languages, Rule Interchange Format (RIF), a framework of web rule language dialects supporting rule interchange on the Web	08	CO4 CO5 CO6

Text Books:

1. The Art of SEO O'Reilly Publication
2. Web Services Essentials by Ethan Cerami O'Reilly Media
3. Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, by Avinash Kaushik, ISBN: 978-0-470-52939-3, wiley publication.
4. "Semantic Web Technologies: Trends and Research in Ontology-based Systems", by John Davies, Rudi Studer, and Paul Warren John, Wiley & Son'
5. Advance Internet Technology by Dr. Deven Shah Dreamtech.

References:

1. RESTful Web Services, By Leonard Richardson, Sam Ruby, O'Reilly Media
2. Rich Internet Application AJAX and Beyond WROX press
3. Handbook of Semantic Web Technologies, by John Domingue, Dieter Fensel, Springer Reference
4. Tim O'Reilly, What is Web 2.0? : Design Patterns and Business Models for the Next Generation of Software, O'REILLY

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDLO6022	Software Architecture	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6022	Software Architecture	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand importance of architecture in building effective, efficient, competitive software product.
2. To understand principal design decisions governing the system.
3. To understand role of architecture in software engineering
4. To understand designing application from architectural perspective
5. To understand different notations used for capturing design decisions.
6. To understand different functional and non-functional properties of complex software systems.

Course Outcomes Students will be able to:

1. Students will cite knowledge of various approaches to document a software system (Remembering)
2. Students will be able to describe functional and non-functional requirements (Understanding)
3. Students will be able to use proper architecture for software (Applying)
4. Students will be able to categorize different components used in the software system (Analyzing)
5. Students will be able to choose from different architectural styles (Evaluating)
6. Students will be able to improve quality of software by selecting proper architecture (Creating)

Prerequisite: Programming Language, UML

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Power of analogy: Architecture of the building, limitations of analogy, The reorientation of software engineering,	02	CO1
I	Introduction to Software Architecture and Software Product Life Cycle	Evolution of Software Development, Fundamentals of Software Engineering, Elements of Software Architecture. Management View, Software Engineering View, Engineering Design View, Architectural View,	07	CO1 CO2
II	Architectural Design Process and Introduction to Software Design	Understanding the problem, Identifying design elements and their relationship, Evaluating the Architecture, Transforming the Architecture, Problems in Software Architectural Design, Function form and Fabrication, The scope of Design, Psychology and Philosophy of Design, General Methodology of Design	09	CO1 CO2 CO3
III	Complexity, Modularity, Models and Knowledge Representation	Complexity, Modularity, What are Models, What are Models used for, What roles do Models Play, Modeling the Problem and Solution Domain, Views,	09	CO1 CO4
IV	Architecture Representation and Architectural Design Principles	Goals of Architecture Representation, Foundation of Architectural Representation, Architectural Description Language, Architectural Level of Design, Architecting with Design Operators, Functional Design Strategies.	09	CO4
V	Architectural Styles, Patterns and Meta models	Defining Architectural Patterns and Style, Common Architectural Styles, Understanding Metamodels, Applying Reference Models, Fundamental Metamodel for describing Software Component	08	CO4 CO5
VI	Architectural Description and Architectural	Standardizing Architectural Description, Creating an Architectural Description, Applying	08	CO1

	Framework, Architecture Quality	Architectural Description, Software Architecture Framework, 4+1 View Model of Architecture, Reference Model for Open Distributed Processing, Importance of Assessing Software Quality, How to improve Quality. DevOps practice and Architecture.		CO6

Text Books:

1. The Art of Software Architecture: Design Methods and Techniques, Stephen T.Albin, Wiley India Private Limited.
2. Software Architecture, Foundations, Theory, and Practise, Richard Taylor, Nenad Medvidovic, Eric M Dashofy, Wiley Student Edition.

References:

1. Software Architecture in Practice by Len Bass, Paul Clements, Rick Kazman, Pearson.
2. DevOps A Software Architect's Perspective, Len Bass, Ingo Weber, Liming Zhu, Addison Wesley

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

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- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDLO6023	Digital Forensics	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6023	Digital Forensics	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand underlying principles and many of the techniques associated with the digital forensic practices and cyber crime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cyber security issues (Computer Security Incident) and analyzed the ways that exploits in securities.
5. To investigate attacks, IDS .technical exploits and router attacks and “Trap and Trace” computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing.

Course Outcomes: Student will able to:

1. Define the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
2. Underline the need of digital forensic and role of digital evidences .
3. Explain the methodology of incident response and various security issues in ICT world, and identify digital forensic tools for data collection .
4. Recognize the importance of digital forensic duplication and various tools for analysis to achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system.
5. Apply the knowledge of IDS to secure network and performing router and network analysis
6. List the method to generate legal evidence and supporting investigation reports and will also be able to use various digital forensic tools .

Prerequisite: Cryptography and Security, Computer Networks

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Cryptography and Security ,Computer Networks	2	
I	Introduction to Cyber Crime and Ethical Hacking	**Introduction of Cybercrime**: Types of cybercrime ,categories of cybercrime , Computers' roles in crimes, Prevention from Cyber crime, Hackers, Crackers, Phreakers **Ethical Hacking** :Difference between Hacking and Ethical hacking : Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaisance tools, scanning tools	6	CO1
II	Introduction to Digital Forensics and Digital Evidences	**Digital Forensic** ,Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics, **Digital Evidences** : Types and characteristics and challenges for Evidence Handling	6	CO2
III	Computer Security Incident Response Methodology	**Introduction to Computer Security Incident** Goals of Incident response, Incident Response Methodology, Formulating Response Strategy, **IR Process** – Initial Response, Investigation, Remediation, Tracking of Significant ,Investigative Information, Reporting **Pre Incident Preparation,** Incident Detection and Characterization. **Live Data Collection** : Live Data Collection on Microsoft Windows Systems: Live Data	11	CO3

		Collection on Unix-Based Systems		
IV	Forensic Duplication and Disk Analysis, and Investigation	**Forensic Duplication** Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools **Disk and File System Analysis:** Media Analysis Concepts, File System Abstraction Model The Sleuth Kit : Installing the Sleuth Kit , Sleuth Kit Tools Partitioning and Disk Layouts : Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers : Virtual Machine Disk Images , Forensic Containers Hashing, Carving : Foremost , Forensic Imaging : Deleted Data , File Slack , dd , dcfldd , dc3dd **Data Analysis** Analysis Methodology Investigating Windows systems , Investigating UNIX systems , Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis	11	CO4
V	Network Forensics	Technical Exploits and Password Cracking , Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks , Analyzing Network Traffic, Collecting Network based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	9	CO5
VI	Forensic Investigation	**Report** :Goals of Report, Layout of an		

	Report and Forensic Tools	Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report . **Computer Forensic Tools** : need and types of computer forensic tools, task performed by computer forensic tools . Study of open source Tools like SFIT, Autopsy etc. to acquire, search, analyze and store digital evidence	7	CO6

Text Books:

1. Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.
2. Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic : The fascinating world of Digital Evidences " Wiley India Pvt Ltd 2017.
3. Cory Altheide, Harlan Carvey "Digital forensics with open source tools "Syngress Publishing, Inc. 2011.
4. Chris McNab, Network Security Assessment, By O'Reily.

References:

1. Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
2. Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
3. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
4. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDLO6024	Multimedia Systems	04	--	---	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6024	Multimedia Systems	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To learn and understand technical aspect of Multimedia Systems.
2. To understand the standards available for different audio, video and text applications.
3. To Design and develop various Multimedia Systems applicable in real time.
4. To learn various multimedia authoring systems.
5. To understand various networking aspects used for multimedia applications.
6. To develop multimedia application and analyze the performance of the same.

Course Outcomes: Students will be able to:

1. Developed understanding of technical aspect of Multimedia Systems.
2. Understand various file formats for audio, video and text media.
3. Develop various Multimedia Systems applicable in real time.
4. Design interactive multimedia software.
5. Apply various networking protocols for multimedia applications.
6. To evaluate multimedia application for its optimum performance.

Prerequisite: Knowledge of computer graphics, computer networking and database systems.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of database, computer networks and computer graphics.	2	--
I	Multimedia Systems Design: An Introduction	Multimedia Elements. Multimedia Systems Architecture, Evolving Technologies for Multimedia Systems, Defining Objects For	9	CO1

		Multimedia Systems. Multimedia Data Interface Standards. The Need for Data Compression. Multimedia applications including digital libraries, system software , streaming videos and its applications.		
II	Compression and Decompression Data and File Format Standards	Types of Compression. Image Compression Schemes. Video Compression. Audio Compression. Rich-Text Format. TIFF File Format. Resource Interchange File Format (RIFF), MIDI File Format. JPEG DIB File Format for Still and Motion Images. JPEG Still Image. AVI video File Format. MPEG Standards.	10	CO1 CO2
III	Multimedia Application Design	Multimedia Application Classes. Types of Multimedia Systems. Virtual Reality Design. Components of Multimedia Systems. Multimedia database issues and solutions. Organizing Multimedia Databases.	8	CO1 CO2 CO3
IV	Multimedia Authoring, User Interface and	Multimedia Authoring Systems. Hypermedia Application Design Considerations. User Interface Design. Information Access. Object Display/Playback Issues	7	CO4
V	Distributed Multimedia Systems	Components of a Distributed Multimedia System. Distributed Client-Server Operation. Middleware in Distributed Workgroup Computing. Multiserver Network Topologies. Distributed Multimedia Databases. Managing Distributed Objects. Application Workflow Design Issues. Distributed Application Design Issues	8	CO4 CO5
VI	System Design: Methodology and Considerations.	Fundamental Design Issues. Determining Enterprise Requirements. Examining Current Architecture and Feasibility. Performance Analysis. Designing for Performance Multimedia System Design. System Extensibility. Multimedia Systems Design Example.	8	CO5 CO6

Text Books:

1. **Prabhat K. Andleigh, Kiran Thakrar** "Multimedia Systems Design" 1/e, Pearson , ISBN 978-93-325-4938-8
2. Fundamentals of Multimedia by Ze-Nian Li& Mark.S.Drew
3. Introduction to Multimedia Communication, Application, Middleware, Networking by K.R.Roa, Zoran S,Bojkovic & Dragorad A. Milovanovic.

References:

1. Organization of Multimedia Resources: Principles and Practice of Information Retrieval by Mary A. Burke
2. Multimedia Systems Design by Prabhat K.Andleigh/ Kiran Thakrar

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO6025	Green IT	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6025	Green IT	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand what Green IT is and How it can help improve environmental Sustainability
2. To understand the principles and practices of Green IT.
3. To understand how Green IT is adopted or deployed in enterprises.
4. To understand how data centres, cloud computing, storage systems, software and networks can be made greener.
5. To measure the Maturity of Sustainable ICT world.
6. To implement the concept of Green IT in Information Assurance in Communication and Social Media and all other commercial field.

Course Outcomes: Students will be able to:

1. Describe awareness among stakeholders and promote green agenda and green initiatives in their working environments leading to green movement
2. Identify IT Infrastructure Management and Green Data Centre Metrics for software development
3. Recognize Objectives of Green Network Protocols for Data communication.
4. Use Green IT Strategies and metrics for ICT development.
5. Illustrate various green IT services and its roles.
6. Use new career opportunities available in IT profession, audits and others with special skills such as energy efficiency, ethical IT assets disposal, carbon footprint estimation, reporting and development of green products, applications and services.

Prerequisite: Environmental Studies

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Environmental Studies	2	
I	Introduction	Environmental Impacts of IT, Holistic Approach to Greening IT, Green IT Standards and Eco-Labeling, Enterprise Green IT Strategy , Green IT: Burden or Opportunity? **Hardware:** Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose. **Software:** Introduction, Energy-Saving Software Techniques, Evaluating and Measuring Software Impact to Platform Power.	9	CO1
II	Software development and data centers	Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics, Sustainable Software Methodology, Data Centres and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, Green Data Centre Metrics	9	CO1 CO2
III	Data storage and communication	Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management, Objectives of Green Network Protocols, Green Network Protocols and Standards.	9	CO1 CO3
IV	Information systems, green it strategy and metrics	Approaching Green IT Strategies, Business Drivers of Green IT Strategy, Business Dimensions for Green IT Transformation, Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Organizational Level Information, Regional/City Level Information, Measuring the Maturity of Sustainable ICT.	8	CO1 CO4

V	Green it services and roles	Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework, Sustainable IT Roadmap, Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware, Inter-organizational Enterprise Activities and Green Issues, Enablers and Making the Case for IT and the Green Enterprise.	9	CO1 CO4 CO5
VI	Managing and regulating green it	Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and Social Media, The Regulatory Environment and IT Manufacturers, Nonregulatory Government Initiatives, Industry Associations and Standards Bodies, Green Building Standards, Green Data Centres, Social Movements and Greenpeace.	6	CO1 CO5 CO6

Text Books:

1. San Murugesan, G. R. Gangadharan, Harnessing Green IT,WILEY 1st Edition-2013
2. Mohammad Dastbaz Colin Pattinson Babak Akhgar, Green Information Technology A Sustainable Approach , Elsevier 2015
3. Reinhold, Carol Baroudi, and Jeffrey HillGreen IT for Dummies, Wiley 2009

References:

1. Mark O'Neil , Green IT for Sustainable Business Practice: An ISEB Foundation Guide, BCS
2.Jae H. Kim, Myung J. Lee Green IT: Technologies and Applications, Springer, ISBN: 978-3-642-22178-1
3. Elizabeth Rogers, Thomas M. Kostigen The Green Book: The Everyday Guide to Saving the Planet One Simple Step at a Time, Springer

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

AC 11.5.2017

Item No. 4.180

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Information Technology

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**

with effect from the AY 2016–17

B. E. Information Technology (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC701	Enterprise Network Design	4	-	-	4	-	-	4
ITC702	Infrastructure Security	4	-	-	4	-	-	4
ITC703	Artificial Intelligence	4	-	-	4	-	-	4
ITDLO-II	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO-I	Institute Level Optional Course-I	3	-	-	3	-	-	3
ITL701	Network Design Lab	-	2	-	-	1		1
ITL702	Advanced Security Lab	-	2	-	-	1		1
ITL703	Intelligence System Lab	-	2	-		1		1
ITL704	Android Apps Development Lab	-	2			1		1
ITM705	Project-I	-	6/8			3	-	3
	Total	**19**	**14**	-	**19**	**7**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC701	Enterprise Network Design	20	20	20	80	3	-		-	100
ITC702	Infrastructure Security	20	20	20	80	3	-		-	100
ITC703	Artificial Intelligence	20	20	20	80	3	-		-	100
ITDLO-II	Department Level Optional Course -III	20	20	20	80	3	-		-	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--		-	100
ITL701	Network Design Lab	-	-	-	-	-	25	25	--	50
ITL702	Advanced Security Lab	-	-	-	-	-	25	25	--	50
ITL703	Intelligence System Lab	--	-	-	-	--	25	25	--	50
ITL704	Android Apps Development Lab						25	25	--	25
ITM705	Project-I	-	-	-	-	-	50	25	--	75
Total		100	100	100	400		150	125	--	750

 # Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VII. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VII, which is

not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester VII			
ITDLO7031	Storage Area Networks	ILO7011	Product Lifecycle Management
ITDLO7032	Mobile Application Development	ILO7012	Reliability Engineering
ITDLO7033	High Performance Computing	ILO7013	Management Information System
ITDLO7034	Software Testing and Quality Assurance	ILO7014	Design of Experiments
ITDLO7035	Soft Computing	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC701	Enterprise Network Design	04	--		04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC701	Enterprise Network Design	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To be familiarized with the methodologies and approaches of the network design for an enterprise network.
2. To understand the network hierarchy and use modular approach to network design for an enterprise network.
3. To understand the campus design and data center design considerations for designing an enterprise campus.
4. To study Enterprise Edge WAN Technologies and design a WAN using them
5. Designing an IP addressing plan and selecting a Route protocol for an enterprise network.
6. To design enterprise network for given user requirements in an application.

Course Outcomes: Student should be able to:

1. Understand the customer requirements and Apply a Methodology to Network Design
2. Structure and Modularize the Network
3. Design Basic Campus and Data Center Network.
4. Design Remote Connectivity
5. Design IP Addressing and Select suitable Routing Protocols for the Network
6. Compare Openflow controllers and switches with other enterprise networks.

Pre-requisite: Computer Networks

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	1. OSI Reference Model and TCP/IP Protocol Suite 2. Routing IP Addresses 3. Internetworking Devices	02	
I	Applying a Methodology to Network Design:	The Cisco Service Oriented Network Architecture, Network Design Methodology, Identifying Customer Requirements, Characterizing the Existing Network and Sites, Using the Top-Down Approach to Network Design, The Design Implementation Process.	08	CO1, CO6
II	Structuring and Modularizing the Network:	Network Hierarchy, Using a Modular Approach to Network Design, *Services Within Modular Networks, Network Management Protocols and Features*	09	CO2, CO6
III	Designing Basic Campus and Data Center Networks	Campus Design Considerations, Enterprise Campus Design, Enterprise Data Center Design Considerations	09	CO3, CO6
IV	Designing Remote Connectivity	Enterprise Edge WAN Technologies, WAN Design, Using WAN Technologies, Enterprise Edge WAN and MAN Architecture, Selecting Enterprise Edge Components, Enterprise Branch and Teleworker Design.	09	CO4, CO6
V	Designing IP Addressing in the Network & Selecting Routing Protocols	Designing an IP Addressing Plan, Introduction to IPv6, Routing Protocol Features, Routing Protocols for the Enterprise, Routing Protocol Deployment, *Route* Redistribution, Route Filtering, Redistributing and Filtering with BGP, Route Summarization	10	CO5
VI	Software Defined	Understanding SDN and Open Flow : SDN – SDN Building		CO6

	Network	Blocks, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages, Implementing OpenFlow Switch, OpenFlow controllers , POX and NOX, Open Flow in Cloud Computing, Case study: how SDN changed Traditional Enterprise network Design	05	

Text Books:

1. Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press-Diane Teare.
2. Network Analysis, Architecture, and Design 3rd Edition, Morgan Kaufman, James D.
3. CCDA Cisco official Guide
4. Software Defined Networking with Open Flow : PACKT Publishing Siamak Azodolmolky

References:

1. Top-Down Network Design (Networking Technology) 3rd Edition, Priscilla Oppenheimer ,Cisco Press Book
2. Network Planning and Design Guide Paperback – 2000, Shaun Hummel

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC702	Infrastructure Security	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC702	Infrastructure Security	20	20	20	80	--	--	100

Course Objectives: Students will try :

1. To understand underlying principles of infrastructure security
2. To explore software vulnerabilities, attacks and protection mechanisms
   To learn security aspects of wireless network infrastructure and protocols
3. To investigate web server vulnerabilities and their countermeasures
4. To develop policies for security management and mitigate security related risks in the organization
5. To Learn the different attacks on Open Web Applications and Web services.
6. To Learn the different security policies.

Course Outcomes: Students will be able to:

1. Understand the concept of vulnerabilities, attacks and protection mechanisms
2. Analyze and evaluate software vulnerabilities and attacks on databases and operating systems
3. Explain the need for security protocols in the context of wireless communication
4. Understand and explain various security solutions for Web and Cloud infrastructure
5. Understand, and evaluate different attacks on Open Web Applications and Web services
6. Design appropriate security policies to protect infrastructure components

Prerequisite: Computer Networks, Cryptography and Network Security

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction	Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC,MAC, RBAC, ABAC, BIBA, Bell La Padula), Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	6	CO1

II	Software Security	**Software Vulnerabilities:** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits **Operating System Security:** Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, File System Security **Database Security:** Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security	12	CO2
III	Wireless Security	Mobile Device Security- Security Threats, Device Security, GSM, UMTS and 4G Security, IEEE 802.11xWireless LAN Security, VPN Security, Wireless Intrusion Detection System (WIDS)	9	CO3
IV	Cloud Security	Cloud Security Risks and Countermeasures, Data Protection in Cloud, Cloud Application Security, Cloud Identity and Access Management, Cloud Security as a Service, SAML, OAuth	8	CO4
V	Web Security	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, DNS Attacks, Web Service Security, Secure Electronic Transaction, Email Attacks, Web Server Security as per OWASP, Firewalls, Penetration Testing	12	CO4, CO5
VI	Information Security and Risk Management	Security Policies, Business Continuity Plan, Risk Analysis, Incident Management, Legal System and Cybercrime, Ethical Issues in Security Management.	5	CO6

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

Reference Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O'Riely

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC703	Artificial Intelligence	04 Hr/Week		--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC703	Artificial Intelligence	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements.
2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems
3. To review the different stages of development of the AI field from human like behavior to Rational Agents.
4. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
5. To create an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal, resolution, etc. that play an important role in AI programs.
6. To introduce advanced topics of AI such as planning, Bayes networks, natural language processing and Cognitive Computing.

Course Outcomes: Students will be able to:

1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.
2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
4. Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.
5. Formulate and solve problems with uncertain information using Bayesian approaches.
6. Apply concept Natural Language processing to problems leading to understanding of cognitive computing. .

Prerequisite: Programming, Data Structures.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisites**	Knowledge of any programming language, Data structures.	**2**	**--**
I	Introduction to Intelligent Systems and Intelligent Agents	Introduction to AI, AI Problems and AI techniques, Solving problems by searching, Problem Formulation. State Space Representation Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent.	07	CO 1 CO 2
II	Search Techniques	**Uninformed Search**: DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening. **Informed Search:** Heuristic functions, Hill Climbing, Simulated Annealing, Best First Search, A*, **Constraint Satisfaction Programming**: Crypto Arithmetic, Map Coloring, N-Queens. **Adversarial Search:** Game Playing, Min-Max Search, Alpha Beta Pruning	11	**CO 2** **CO 3**
III	Knowledge and Reasoning	A Knowledge Based Agent, Overview of Propositional Logic, First Order Predicate Logic, Inference in First Order Predicate Logic: Forward and Backward Chaining, Resolution.	10	**CO 4**
IV	Planning	Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning.	06	**CO 4**
V	Uncertain Knowledge and Reasoning	Uncertainly, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes' theorem, Belief Networks, Simple Inference in Belief Networks.	06	**CO 5**
VI	Natural Language	Language Models, Natural Language for Communication:	10	**CO 6**

	Processing	Syntactic Analysis, Augmented Grammars and Semantic Interpretation, Machine Translation. **Overview of Cognitive Computing:** Foundation of Cognitive Computing, List of Design Principles for Cognitive Systems, Natural Language Processing in Support of a Cognitive System **(First three chapters from Text book 3)**		

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.
2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition
3. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley India

References:

1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.
2. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
5. John Kelly , Steve Hamm, Smart Machines - IBM′s Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL701	Network Design Lab	--	2	--	--	2	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL701	Network Design Lab	--	--	--	--	25	25	--	50

Lab Objectives: Students will try:

1. To be familiarized with the requirements of an enterprise and address its major design areas
2. To recognize the hierarchical network model for the enterprise
3. Identify the networking devices and their configurations required for the design and also prepare a bill of materials
4. Propose a design for the Server Farm of an enterprise network and discuss up gradations if needed.
5. Provide suitable IP addressing plan and best possible routing protocol for an enterprise network.
6. Construct a suitable design for an enterprise network and test it using a tool.

Lab Outcomes: Students will be able to:

1. Understand the requirements of an enterprise and outline its major design areas
2. Identify functional areas to construct high level modules for enterprise architecture and analyze them.
3. Identify the networking devices, prepare a bill of materials and configure the devices as per the Core, Acess and Distribution layers
4. Design the Server Farm for an enterprise network and discuss up gradations if needed.
5. Identify and select the technology for Remote site Connectivity**,** suitable IP addressing plan and routing protocol for an enterprise network.
6. Test and monitor the enterprise network using a tool

Prerequisite: Computer Networks.

Guidelines

1. The case study of College Campus Network must be designed as a mini project work which is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must understand the requirements of a College campus enterprise network.
4. The students must outline the major design areas of a College campus enterprise network.
5. The students must identify the functional areas and construct high level modules for the College campus enterprise architecture.
6. The students must analyze the existing College campus enterprise network and propose up gradations to existing infrastructure.
7. The students must identify the network devices required and their locations to design a College campus enterprise network.
8. The students must configure the network devices required as per the Core Layer, Access Layer and Distribution Layer.
9. The students must Design the Server Farm for enterprise network using a configuration tool and also discuss if any other improvement is required.
10. The students must Prepare a bill of materials of all the networking devices. Develop a Request for Proposal-RFP for the enterprise network
11. The students must identify the technology for Remote Site connectivity and evaluate it as per the application requirements of the college campus enterprise network.
12. Propose a suitable IP addressing plan for the enterprise network.
13. Determine a suitable routing protocol for the enterprise network.
14. Create and Test the designed college campus enterprise network using a tool.
15. Use Nagios tool for enterprise infrastructure monitoring tool
16. Each group may present their work in various project competitions and paper presentations.
17. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press-Diane Teare.
2. Designing and Supporting Computer Networks, CCNA Discovery Learning Guide (Cisco Systems Networking Academy Program) Paperback – 2008, Kenneth Stewart , Aubrey Adams, Allan Reid , Jim Lorenz.

References:

1. 1. Top-Down Network Design (Networking Technology) 3rd Edition, Priscilla Oppenheimer ,Cisco Press Book
2. Network Planning and Design Guide Paperback – 2000, Shaun Hummel

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITL702	Advance Security Lab	--	02	-	--	01	-	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL702	Advance Security Lab	--	--	--	--	25	--	25	50

Lab Objective: Students will try to:

1. Implement and analyze program and database vulnerabilities Buffer overflow and SQL Injection.
2. Explore and analyze different security tools to secure mobile devices, web browser, wireless network and router
3. Explore reconnaissance, attack and forensics tools in Kali Linux
4. Learn security of system using personal firewall installation
5. Understand AAA using RADUIS
6. Understand AAA using TACACS

Lab Outcome: Students will able to:

1. Implement and analyze program and database vulnerabilities Buffer overflow and SQL Injection.
2. Explore and analyze different security tools to secure mobile devices, web browser, wireless network and router
3. Explore reconnaissance, attack and forensics tools in Kali Linux
4. Learn security of system using personal firewall installation
5. Understand AAA using RADUIS
6. Understand AAA using TACACS

Prerequisite: Computer Networks, Cryptography and Network Security.

Hardware	**Software**
PC i3 or above configuration.	Kali Linux, Java, Snort, Kismet, Metasploit, Wireshark, Droidcrypt

Detail Syllabus:

Sr. No	Description	Hours	CO mapping
1	Exploring Kali Linux and the inbuilt tools for reconnaissance and ethical hacking.	2	LO3
2	Implementation and analysis of SQL injection Attack	4	LO1
3	Implementation of Buffer overflow attack and its analysis using Splint, Cppcheck etc.	2	LO1
4	Setting up personal Firewall using Iptables	2	LO4
5	Exploring wireless security tools like Kismet, NetStumbler etc.	2	LO2
6	Performing a penetration testing using Metasploit	2	LO3
7	Exploring Router security, access lists using packet tracer	2	LO2
8	Exploring VPN security using Packet tracer	2	LO2
9	Exploring Authentication and access control using RADIUS, TACACS and TACACS+	2	LO5

10	Install and use a security app on an Android mobile (e.g. Droidcrypt)	2	LO2
11	Explore forensics tools in Kali Linux for acquiring, analyzing and duplicating data	2	LO3
12	Configuration of mod Security, core rule set on apache server.	2	LO2

Text Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, TIm Boyles, Sybex

Reference Books:

1. Network Security Bible, Eric Cole, Wiley India

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL703	Intelligence System Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL703	Intelligence System Lab	--	--	--	--	25	--	25	50

Course Objectives: Students will try:

1. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems
2. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques.
3. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications
4. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines
5. To impart a basic understanding of some of the more advanced topics of AI such as planning.
6. To understand Bayes networks, natural language processing and introduce concept of cognitive computing.

Course Outcomes: Students will be able to:

1. Design the building blocks of an Intelligent Agent using PEAS representation .
2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
4. Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.
5. Formulate and solve problems with uncertain information using Bayesian approaches.
6. Apply concept Natural Language processing and cognitive computing for creation of domain specific ChatBots.

Hardware	**Software**
PC i3 or above configuration.	Java Python

Detailed syllabus:

Module No.	Detailed Content	Hours	LO Mapping
1	Tutorial exercise for a) Design of Intelligent System using PEAS. b) Problem Definition with State Space Representation	2	LO 1, LO 2
11	Implementation of Uninformed and Informed Search Algorithms.	6	LO 2
111	Implementation of CSP and Game playing algorithms .	4	LO 3
1V	a) Assignment on Predicate Logic, for forward and backward reasoning and resolution. b) Design of a Planning system using STRIPS.	4	LO 4
V	Implementation of Bayes' Belief Network.	2	LO 5
VI	**Mini project** Construction of a domain specific ChatBot using Natural Language Processing techniques. (Applications can include : Medical Diagnosis, Personal Shopping Assistant, Travel Agent , Trouble shooting etc.)	8	LO6

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.

2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley India

References:

1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.

2. John Kelly , Steve Hamm, Smart Machines - IBM′s Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment + Mini-Project) + 5 Marks (Attendance) **Oral Exam:** An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL704	Android Apps Development Lab		2			1		1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of twoTests					
ITL704	Android Apps Development Lab	--	--	--	--	25	--	25	50

Hardware	**Software**
PC i3 or above configuration.	Java Android SDK

Lab Objectives: Students will try:

1. To gain knowledge of installing Android Studio and Cross Platform Integrated Development Environment.
2. To learn designing of User Interface and Layouts for Android App.
3. To learn how to use intents to broadcast data within and between Applications.
4. To use Content providers and Handle Databases using SQLite.
5. To introduce Android APIs for Camera and Location Based Service.
6. To discuss various security issues with Android Platform.

Lab Outcomes: Students will be able to:

1. Experiment on Integrated Development Environment for Android Application Development.
2. Design and Implement User Interfaces and Layouts of Android App.
3. Use Intents for activity and broadcasting data in Android App.
4. Design and Implement Database Application and Content Providers.
5. Experiment with Camera and Location Based service.
6. Develop Android App with Security features.

Prerequisite: Java Programming, Internet Programming**.**

Guidelines

1. The mini project work is to be conducted by a group of three students

2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.

3. The students may do survey for different application which they can create Apps using Android.

4. Students will do Installation, configuration of Android Studio & to create AVD and also try for Cross platform Integrated Development Environment (Any Open Source Tool).

5. Students will try to Design and implement following points in their Mini Project (Android Apps)

    a. Widget box for Android phone.

    b. Use Layouts

    c. Use Intents

    d. Use Activity

    e. Use SQLite

    f. Use Camera

    g. Use Location API

    h. Generate APK file

6. Each group along with the concerned faculty shall identify a potential problem statement for Apps development, on which the study and implementation is to be conducted.

7. Each group may present their work in various project competitions and paper presentations.

8. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1.Professional Android 4 Application Development by wrox publication
2.Android Cookbook by o'reilly
3. Beginning Android Development Wrox Press

References:

1. Android Application Development For Dummies, 2nd Edition by MichaelBurton, DonnFelker
2. Android Security –attack and defenses, AbhishekDubey and AnmolMisra by CRC Press

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM705	Project-I	--	06	--	--	3	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITM705	Project-I	--	--	--	--	50	--	25	75

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students
2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.
3. Department has to allocate 1 day in VII semester and 2 day in VIII semester every week.
4. Students will do literature survey in Sem VI or Sem VII.
5. Students will do design, implementation and coding in Sem VII.

6. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.

7. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.

8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.

9. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.

10. Students will do testing and analyze in Sem VIII

11. Teams must analyze all the results obtained by comparing with other standard techniques.

12. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.

2. Each team will prepare a report that will summarize the results of the literature survey and implementation and coding as project proposal in SEM VII. The list of papers surveyed must be clearly documented.

3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.

4. Oral exam will be conduct on the project done by the students.

Term Work:
Term Work shall consist of full Project-I on above guidelines/syllabus.

Term Work Marks: 50 Marks (Total marks) = 45 Marks (Project-I) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Project-I and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7031	Storage Area Network	04	--	--	04	--	01	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7031	Storage Area Network	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1. Understand the need for Storage Area Network and Data protection to satisfy the information explosion requirements
2. Study storage technologies: SAN, NAS, IP storage etc., which will bridge the gap between the emerging trends in industry and academics.
3. To get an insight of Storage area network architecture, protocols and its infrastructure.
4. To study and discuss the applications of SAN to fulfill the needs of the storage management in the heterogeneous environment..
5. Study and understand the management of Storage area Networks.
6. To understand and analyze case studies on the storage area network technology

Course Outcomes: Students will able to:

1. Students will analyze the limitations of the client-server architecture and evaluate the need for data protection and storage centric architectures such as Intelligent storage system..
2. Students will understand, interpret and examine various SAN technologies.
3. Students will describe and sketch the SAN architecture and its uses.
4. Students will classify the applications as per their requirements and select relevant SAN solutions.
5. Students will understand and evaluate different SAN management strategies to fulfill business continuity requirements.
6. Students will design case studies on NAS, SAN and SAN/ NAS

Prerequisite: Computer Networks, Operating System

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Networking Protocols, File system and Memory management	02	
I	Introduction to Storage System	Introduction: Storage oriented architecture, Storage Systems, Data center Infrastructure, Challenges in managing information, Information life cycle; Basics of Storage System: Components of Storage System, Disk Drive components and Performance, Components of Host; Data Protection: Raid Components and types, RAID technologies and RAID levels, RAID impact on disk performance; Intelligent Storage System" Components of ISS, Storage Provisioning and types of ISS	09	CO1
II	Network Attached Storage	Storage on Network: NAS hardware and software architecture, NAS connectivity, NAS as a Storage System; NAS Hardware devices; NAS software components; NAS connectivity options: NAS connectivity hardware and Software Architecture.	07	CO2
III	Storage Area Networks	Architecture Overview: Creating Network for storage; Hardware devices: Fibre Channel Switch, Host Bus Adaptors, Putting the Storage in SANs, Fabric Operation from a hardware perspective, SAN hardware considerations ; Software Components: The switch's operating system, device drivers, the supporting components, considerations for SAN software ; Configuration options for SANs: Connecting into the data center, the evolving network and device connections, SAN configuration guidelines	10	CO3

IV	Applications-Putting it together	Defining the I/O workload: Storage planning and capacity planning, the definition and characterization of workloads, the business application, I/O content and workloads, Considerations for I/O workloads in storage networking ; Applying SAN solution: SAN workload characterization, applying SAN to OLTP workloads, transactional workloads; Applying NAS solution: NAS workload characterization, applying NAS to departmental workloads, enterprise web workloads and specialized workloads; Considerations when integrating SN and NAS: Differences and similarities, the need to integrate, future storage connectivity and integration	10	CO4
V	Management	Planning business continuity: Defining the environment, the role of storage networking in business continuity, storage design and implementation of the business continuity planning ; Managing availability: Availability Metrics, Implementing the plan ; Maintaining Serviceability: Tracking the configurations, Investigating the changes and closing the loop on serviceability; Capacity Planning: Storage Analysis, developing and implementing plan for storage, Modelling performance and capacity requirements ; Security considerations: Overview of Information security, Security methods, Storage Security challenges, FC SAN security, NAS security	09	CO5
VI	Case studies	Case studies on NAS, SAN, SAN/NAS	05	CO6

Text Books:

1. Storage Networks: The Complete Reference. Spalding, Robert ,Tata McGraw-Hill Education, 2003
2. “Storage Network Management and Retrieval”, Vaishali Khairnar, Nilima Dongre. Wiley

References:

1. Richard Barker, Paul Massiglia, “Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs”, Wiley India
2. Ulf Troppens,Wolfgang Muller-Friedt,Rainer Wolafka, “Storage Networks Explained” Wiley Publication
3. G. Somasundaram, Alok Shrivastava, “Information Storage and Management”, EMC Education services”, Wiley Publication

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITDLO7032	Mobile Application Development	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7032	Mobile Application Development	20	20	20	80	-	-	--	100

Course Objectives: Students will try:

1. To introduce Android platform and its architecture.
2. To learn activity creation and Android UI designing.
3. To be familiarized with Intent, Broadcast receivers and Internet services.
4. To work with SQLite Database and content providers.
5. To integrate multimedia, camera and Location based services in Android Application.
6. To explore Mobile security issues.

Course Outcomes: Students will be able to:

1. Describe Android platform, Architecture and features.
2. Design User Interface and develop activity for Android App.
3. Use Intent , Broadcast receivers and Internet services in Android App.
4. Design and implement Database Application and Content providers.
5. Use multimedia, camera and Location based services in Android App.
6. Discuss various security issues in Android platform.

Prerequisite: Internet Programming, Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of HTML5,CSS3 & XML	02	-
I	Introduction to Android and Architecture of	Introduction of Android platform, Android features ,Android Marketplace, Evolution of Android OS, Android	07	CO1

	Android	Application Architecture, Developing for Android, Developing for Mobile and Embedded Devices, Android Development Tools		
II	Applications, Activities and Building User Interface	Application: Application Manifest File,Externalizing Resources,Android Application Lifecycle and Android Application Class. Android Activity: Creating activities, Activity lifecycle and Android Activity classes. User Interface:Fundamental Android UI Design, Layouts, Fragments, Designing UI with views, Creating new views, widget toolbox, Adapters.	09	CO2
III	Intents, Broad cast receiver and Internet Resources	Introducing Intents, Linking Activities Using intents , Calling Built-in Applications Using intents , Displaying notifications, Creating Intent Filters and Broadcast Receivers,Downloading and Parsing Internet Resources,Using the Download Manager,Internet Services, Connecting to Google App Engine, Downloading Data Without Draining the Battery	09	CO3
IV	Data Persistence and Content Providers	Introducing Android Databases,Introducing SQLite, Content Values and Cursors,Working with SQLite Databases,Parsing an XMLdocument ,Parsing JSON data . Creating Content Providers, Using Content Providers,Adding Search to Your Application,Native Android Content Providers	09	CO4
V	Audio, Video ,Camera, Maps, Geocoding and Location Based services	Playing Audio and Video,Manipulating Raw Audio,Using Audio , Using the Camera for Taking Pictures,Recording Video,Using Media Effects ,Adding Media to the Media Store. Using Location-Based Services ,Using the Emulator with Location-Based Services,Selecting a Location Provider,Finding Your Current Location, Location Updates,Proximity Alerts,Geocoder, Map-Based Activities,Displaying Maps	08	CO5
VI	Securing and Publishing Android Application	Android Security Model,Android's Manifest Permissions,Mobile Security Issues,Recent Android Attacks,Pen Testing Android. Preparing for Publishing, Deploying	08	CO6

		APK Files		

Text Books:

1. Professional Android 4 Application Development,Retomeier, by wrox publication,
2. Android Security –attack and defenses, AbhishekDubey and AnmolMisra by CRC Press
3. Beginning Android Application Development, Wei-meng lee, by wrox publication

References:

1. Android Application Development For Dummies, 2nd Edition by Michael Burton, DonnFelker
2. Android Cookbook by o'reilly

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDLO7033	High Performance Computing	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7033	High Performance Computing	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1. Learn the concepts of parallel processing as it pertains to high-performance computing.
2. Learn to design parallel programs on high performance computing.
3. Discuss issues of parallel programming.
4. Learn the concepts of message passing paradigm using open source APIs.
5. Learn different open source tools.
6. Learn the concepts of Multi-core processor.

Course Outcomes: Students will be able to:

1. Memorize parallel processing approaches
2. Describe different parallel processing platforms involved in achieving High Performance Computing.
3. Discuss different design issues in parallel programming
4. Develop efficient and high performance parallel programming
5. Learn parallel programming using message passing paradigm using open source APIs.
6. Design algorithms suited for Multicore processor and GPU systems using OpenMP and CUDA

Prerequisite: Computer Organization

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO mapping
1	Introduction	Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation), Parallel Architectures: Interconnection network, Processor Array, Multiprocessor	7	CO1
2	Parallel Programming Platforms	Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor & Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	7	CO2
3	Parallel Algorithm Design	Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, Basic Communication operations: Broadcast and Reduction Communication types	12	CO3
4	Performance Measures	Performance Measures : Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks	5	CO4
5	Fundamental Design Issues in HPC	Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations,	12	CO5

		One-Dimensional Matrix-Vector Multiplication, Single-Source Shortest-Path, Sample Sort, Groups and Communicators, Two-Dimensional Matrix-Vector Multiplication, Introduction to OpenMP,		
6	General Purpose Graphics Processing Unit(GPGPU)	CUDA enabled GPGPU, GPGPU architecture, GPGPU programming using CUDA, Introduction to CUDA Programming	9	CO6

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPU Programming", Addison-Wesley Professional ©, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.

Reference Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7034	Software Testing and Quality Assurance	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7034	Software Testing and Quality Assurance	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1 Basic software debugging methods.
2 White box testing methods and techniques.
3 Black Box testing methods and techniques.
4 Designing test plans.
5 Different testing tools (familiar with open source tools)
6 Quality Assurance models.

Course Outcomes: Students will be able to:

1. Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.
2. Implement various test processes for quality improvement
3. Design test planning.
4. Manage the test process
5. Apply the software testing techniques in commercial environment
6. Use practical knowledge of a variety of ways to test software and an understanding of some of the trade-offs between testing techniques.

Prerequisite: Software Engineering.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Software Engineering Concepts**	02	--
I	Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology, Verification and Validation, Verification requirements, Verification of high level design, Verification of low level design, validation.	09	CO1
II	Testing Techniques	Dynamic Testing: Black Box testing: boundary value analysis, equivalence class testing, state table based testing, cause-effect graphing based testing, error guessing. White box Testing Techniques: need, logic coverage criteria, basis path testing, graph matrices, loop testing, data flow testing, mutation testing. Static Testing. Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, regression testing produces quality software, regression testability, objectives of regression testing, regression testing types, define problem, regression testing techniques.	08	CO2 CO3
III	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and test specification. Software Metrics: need, definition and classification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding metrics, estimation model for testing effort, architectural design, information flow	08	CO4

		matrix used for testing, function point and test point analysis. Efficient Test Suite Management: minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization its type , techniques and measuring effectiveness.		
IV	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium etc.	09	CO1 CO5
V	Testing for specialized environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, traditional software and web based software, challenges in testing for web based software, testing web based testing	08	CO2 CO3
VI	Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO 9126 quality characteristics, ISO9000:2000, Software quality management	06	CO6

Text Books :

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy , Wiley Publication

References :

1. Effective Methods for Software Testing , third edition by Willam E. Perry, Wiley Publication

2. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , Dreamtech press

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7035	Soft Computing	04	--	01	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7035	Soft Computing	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To familiarize with soft computing concepts.
2. To introduce the fuzzy logic concepts, fuzzy principles and relations.
3. To Basics of ANN and Learning Algorithms.
4. Ann as function approximation.
5. Genetic Algorithm and its applications to soft computing.
6. Hybrid system usage, application and optimization.

Course Outcomes: Students will be able to:

1. List the facts and outline the different process carried out in fuzzy logic, ANN and Genetic Algorithms.
2. Explain the concepts and meta-cognitive of soft computing.
3. Apply Soft computing techniques the solve character recognition, pattern classification, regression and similar problems.
4. Outline facts to identify process/procedures to handle real world problems using soft computing.
5. Evaluate various techniques of soft computing to defend the best working solutions.
6. Design hybrid system to revise the principles of soft computing in various applications.

Prerequisite: NIL

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Probability and Statistics, C++/Java/ Matlab	02	

		programming.		
I	Fuzzy Set Theory	Fuzzy Sets: Basic definition and terminology, Basic concepts of fuzzy sets, Fuzzy set operations, Fuzzy relations: Cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations, Fuzzy composition Fuzzification and Defuzzification: Features of the membership Functions, Fuzzification, Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification methods	06	CO1 CO2
II	Fuzzy Rules, Reasoning, and Inference System	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between , Mamdani and Sugeno FIS.	06	CO1 CO2
III	Neural Network-I	Introduction: What is a Neural network? Fundamental Concepts, Basic Models of Artificial Neural Networks, Arificial Intelligence and Neural Networks, McCulloch-Pitts Neuron Learning: Error-Correction Learning, Memory based Learning, Hebbian learning, Competitive Learning, Boltzmann Learning Perceprton: Perceprton Learning Rule, Perceptron Learning Algorithm, Perceprton Convergence Theorem, Perceptron learning and Non-separable sets.	09	CO1 CO2
IV	Neural Networks -II	Back propaggation: Multilayered Network Architecture, Back porpagation Algorithm, Practical Consideration in impin Implementing the Back propagation Algorithm. Back propagation and XOR problem. Adaptive resonance Theory: Noise-Saturation Dilemma, Solving the Noise-Saturation Dilemma, Recurrent On-center-Off-surround Networks, Building blocks of Adaptive Resonance, Substrate of resonance, Structural details of the resonance Model, Adaptive Resonance Theory I (ART I), Neurophysiological Evidence for ART Mechanism Character Recognition: Introduction, General Algorithm Architecture for Character Recognition: Binarization, Preprocessing, Filters, Smoothing, Skew Detection and Correction, Slant Correction, Character Normalization, Thinning, Segmentation, Multilingual OCR by Rule-Based Approach and ANN	10	CO3 CO6

		Rule-Based Approach: Classification, Tests, Rules Artificial Neural Network: Inputs, Outputs, Identification Results of Multilingual OCR		
V	Genetic Algorithm	An Introduction to genetic Algorithms: What Are Genetic Algorithms? Robustness of Traditional Optimization and Search Methods, The Goals of Optimization, How Are Genetic Algorithms Different from Traditional Methods?, A Simple Genetic Algorithm Genetic Algorithms at Work—a Simulation by hand, Grist for the Search Mill—Important Similarities, Similarity Templates (Schemata), Learning the Lingo. Genetic Algorithms: Mathematical Foundations Who Shall Live and Who Shall Die? The Fundamental Theorem, Schema Processing at Work: An Example by Hand Revisited, The Two-armed and й-armed Bandit Problem, How Many Schemata Are Processed Usefully? The Building Block Hypothesis, Another Perspective: The Minimal Deceptive Problem, Schemata Revisited: Similarity Templates as Hyperplanes, Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, A Time to Reproduce, a Time to Cross, Get with the Main Program, How Well Does it Work? Mapping Objective Functions to Fitness Form, Fitness Scaling, Codings, A Multiparameter, Mapped, Fixed-Point Coding, Discretization, Constraints. Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA: Deviation between Two Edges, Deviation of a Graph, Crossover: Matching of Points, Generate Adjacency Matrix, Find Paths, Removing and Adding Edges, Generation of Graph Results of Handwriting Recognition: Effect of Genetic Algorithms, Distance Optimization, Style Optimization	10	CO1 CO3 CO6
VI	Hybrid Computing	Introduction, Neuro-Fuzzy Hybrid Systems, Adaptive Neuro-Fuzzy Inference System (ANIFS): Introduction, ANFS Architecture, Hybrid Learning Algorithm, ANFIS as a Universal Approximator, Simulation Examples: Two-input Sinc Function and Three Input Nonlinear Function Genetic Neuro-Hybrid Systems: Properties of Genetic Neuro-Hybrid Systems, genetic Algorithm based Back-propagation Network, Advantages of Neuro-Genetic Hybrids, Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems Genetic Fuzzy Rule based Systems, Advantages of Genetic Fuzzy Hybrids	09	CO4 CO6

Text Books:

1. . S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007, ISBN: 10: 81-265-1075-7.
2. J.-S. R. Jang, C. –T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence, PHI Learning Private Limited-2014
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education, 2004/2007
4. Simon Haykin, Neural Networks A Comprehensive Foundation, Second Edition, Pearson Education-2004
5. David E. Goldberg, Genetic Algorithms, in search, optimization and Machine Learning, Pearson

References:

1. Anupam Shukla, Ritu Tiwari, Rahul Kala, Real Life Applications of Soft Computing, CRC Press, Taylor & Francis Group, 2010.
2. Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications © 2009 Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, CRC Press
3. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Course Objectives: Students will try :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Course Outcomes: Students will be able to :

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10^{th} Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07

05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts,	05

	Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of	06

	casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To provide an exposure toimplications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To familiarise the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Demonstrateunderstanding of knowledge for Rural Development.
2. Prepare solutions for Management Issues.
3. Take up Initiatives and design Strategies to complete the task
4. Develop acumen for higher education and research.
5. Demonstrate the art of working in group of different nature
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	06
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	07

4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington

9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150
10. Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

B. E. Information Technology (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC801	Big Data Analytics	4	-	-	4	-	-	4
ITC802	Internet of Everything	4	-	-	4	-	-	4
ITDLO-IV	Department Level Optional Course-IV	4	-	-	4	-	-	4
ILO-II	Institute Level Optional Course-II	3	-	-	3	-	-	3
ITL801	Big Data Lab	-	2	-	-	1		1
ITL802	Internet of Everything Lab		2			1		1
ITL803	DevOps Lab	-	2	-	-	1		1
ITL804	R Programming Lab	-	2	-		1		1
ITM805	Project-II	-	16			8	-	8
	Total	**15**	**24**	-	**15**	**12**	-	**27**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
ITC801	Big Data Analytics	20	20	20	80	3	-	-	-	100
ITC802	Internet of Everything	20	20	20	80	3	-	-	-	100
ITDLO-IV	Department Level Optional Course-IV	20	20	20	80	3	-	-	-	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
ITL801	Big Data Lab						25	25	-	50
ITL802	Internet of Everything Lab	-	-	-	-	-	25	25		50
ITL803	DevOps Lab	-	-	-	-	-	25	--	25	50
ITL804	R Programming Lab	-	-	-	-	-	25	--	25	50
ITM805	Project-II						100	50	--	150
Total		80	80	80	320	--	200	100	50	750

 # Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VIII. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VIII, which is

not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester VIII			
ITDLO8041	User Interaction Design	ILO8021	Project Management
ITDLO8042	Information Retrieval Systems	ILO8022	Finance Management
ITDLO8043	Knowledge Management	ILO8023	Entrepreneurship Development and Management
ITDLO8044	Robotics	ILO8024	Human Resource Management
ITDLO8045	Enterprise Resource Planning	ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC801	Big Data Analytics	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC801	Big Data Analytics	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To provide an overview of an exciting growing field of Big Data analytics.
2. To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5. To introduce to the students several types of big data like social media, web graphs and data streams.
6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes: Student will be able to:

1. Explain the motivation for big data systems and identify the main sources of Big Data in the real world.
2. Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store retrieve and process Big Data for Analytics.
3. Implement several Data Intensive tasks using the Map Reduce Paradigm
4. Apply several newer algorithms for Clustering Classifying and finding associations in Big Data
5. Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.
6. Design and implement successful Recommendation engines for enterprises.

Prerequisites: Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisites**	Data Mining, database Systems, Algorithms	02	--
I	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	03	CO 1
II	Introduction to Big Data Frameworks: Hadoop, NOSQL	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; **Overview of** : Apache Spark, Pig, Hive, Hbase, Sqoop **What is NoSQL?** NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, **Mongo DB**	10	CO 2
III	MapReduce Paradigm	**MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. **Algorithms Using MapReduce:** Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step . **Illustrating** use of MapReduce with use of real life databases and applications.	09	CO 3
IV	Mining Big Data Streams	**The Stream Data Model:** A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. **Sampling Data in a Stream :** Sampling Techniques. **Filtering Streams:** The Bloom Filter	07	CO 5

		Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . **Counting Ones in a Window:** The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm.		
V	Big Data Mining Algorithms	**Frequent Pattern Mining** : Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. **Clustering Algorithms:** CURE Algorithm. Canopy Clustering, Clustering with MapReduce **Classification Algorithms:** Parallel Decision trees, Overview SVM classifiers, Parallel SVM, K-Nearest Neighbor classifications for Big Data, One Nearest Neighbour.	10	CO 4
VI	Big Data Analytics Applications	**Link Analysis** : PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. **Mining Social- Network Graphs** : Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. **Recommendation Engine**s: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	11	CO 4 CO 6

Text Books:

1. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications,
2. Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press.
3. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
4. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
5. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications

References:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC802	Internet of Everything	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC802	Internet of Everything	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To learn the concepts of IOT.
2. To identify the different technology.
3. To learn different applications in IOT.
4. To learn different protocols used in IOT.
5. To learn the concepts of smart city development in IOT.
6. To learn how to analysis the data in IOT.

Course Outcomes: Student will be able to:

1. Apply the concepts of IOT.
2. Identify the different technology.
3. Apply IOT to different applications.
4. Analysis and evaluate protocols used in IOT.
5. Design and develop smart city in IOT.
6. Analysis and evaluate the data received through sensors in IOT.

Prerequisites: IOT Lab, Sensor Lab, Wireless Network.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisites**	What are sensors, Sensor family, Architecture of single node sensor?	02	--
I	Introduction	Introduction, History of IOT, Objects in IOT, Identifier in the IOT, Technologies in IOT	03	CO 1
II	RFID Technology	Introduction, principle of RFID, components of RFID system: RFID tag, Reader, RFID middleware,	8	CO 2

		Issues etc.		
III	RFID Applications	Introduction, concepts and technology: RFID, transponder, RFID architecture, RFID applications i.e. logistics and supply chain, production, monitoring and maintenance, product safety, quality and information, access control and tracking and tracing of individuals, payment, loyalty, household etc. Hardware, Hardware issues, protocols: pure aloha, slotted aloha, frame slotted aloha, tree protocols, tree splitting algorithms, binary search algorithms, bitwise arbitration protocols. Main query tree protocols.	09	CO2 CO 3
IV	Wireless Sensor Networks	History and context, Node, connecting nodes, networking nodes, securing communication, standards and Fora. Networking and the Internet - IP Addressing, Protocols - MQTT, CoAP, REST Transferring data	09	CO2 CO3 CO4
V	Mobility and Settings.	Introduction, localization, mobility management, localization and handover management, technology considerations, performance evaluation, simulation setup, performance results. Identification of IOT (data formats. IPV6, identifiers and locators, tag etc.)	10	CO4 CO5
VI	Data Analytics for IoE	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study - Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator.	11	CO5 CO6

Text Books:

1 Internet of Things connecting objects to the web, by Hakima Chaouchi, Wiley.
2. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

1 The Internet of Things (MIT Press) by Samuel Greengard.
2 The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
3 RFID and the Internet of Things, by Herve chabanne, Wiley

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL801	Big Data Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL801	Big Data Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce the tools required to manage and analyze big data like Hadoop, NoSql
2. To impart knowledge of Map reduce paradigm to solve complex problems Map-Reduce.
3. To introduce several new algorithms for big data mining like classification, clustering and finding frequent patterns.
4. To introduce to the students several types of big data like social media, web graphs and data streams.
5. To identify various sources of Big data
6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Lab Outcomes: Students will be able to:

1. Demonstrate capability to use Big Data Frameworks like Hadoop
2. Program applications using tools like Hive, pig, , NO SQL and MongoDB for Big data Applications
3. Construct scalable algorithms for large Datasets using Map Reduce techniques
4. Implement algorithms for Clustering, Classifying and finding associations in Big Data
5. Design and implement algorithms to analyze Big data like streams, Web Graphs and Social Media data and construct recommendation systems.
6. Apply the knowledge of Big Data gained to fully develop a BDA applications for real life applications.

Prerequisite: Java, Python

Requirement

Hardware	Software
PC i3 or above, 8 GB RAM	Virtual Machine, Hadoop Frame work, NOSQL and MongoDb Compilers

Detailed syllabus:

Module	Detailed Content	Hours 2hrs	LO Mapping
1	Assignment on Study of Hadoop ecosystem	02	LO 1
2	Programming exercises on Hadoop Using Hive, Pig, Hbase Sqoop NOSQL, MongoDB	04	LO 2
3	Implementing simple algorithms in Map-Reduce Matrix multiplication, Aggregates, joins, sorting, searching etc.	04	LO3
4	Implementing Algorithms using MapReduce (Any 2) • Implementing Frequent Item set Mining • Implementing Clustering algorithms • Implementing Classification Algorithms	06	LO 4
5	Big Data Applications (Any 2) • Implementing Analytics on data streams • Implementing Social Network Analysis Algorithms • Implementing Web Graph Algorithms • Implementing recommendation Engines	05	LO 5
6	**Mini Project**: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines (list of datsets also given in the text book)	05	LO 5 LO 6

Text Books:

1. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications,
2. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
3. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
4. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications

References:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services
4. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence by Pramod J. Sadalage, Addison Wesley

Term Work:
Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL802	Internet of Everything Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL802	Internet of Everything Lab	--	--	--	--	25	--	25	50

Hardware and Software requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Hard disk	1. Ubuntu or Linux Desktop OS 2. VMware 3. Cooja contiki or any open source software 4. Cupcarbon	1. Internet Connection

Lab Objectives: Students will try:

1. To learn different types of sensors from Motes families.
2. To design the problem solution as per the requirement analysis done using Motes sensors.
3. To study the basic concepts of programming/sensors/ emulator like cooja etc.
4. To design and implement the mini project intended solution for project based learning.
5. To build and test the mini project successfully.
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.

4. Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Prerequisite: Basics of Java and Python Programming

Guidelines

1. The mini project work is to be conducted by a group of three students

2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.

3. The students must understand the

a. Concept

b. Importance

c. Interdisciplinary

d. Challenges

e. Various applications/smart objects

f. Major Players/Industry, Standards.

4. The students must understand the IoT Architecture:

a. Node Structure: Sensing, Processing, Communication, Powering

b. Networking: Topologies, Layer/Stack architecture

c. Communication Technologies: Introduction to ZigBee, BLE, WiFi, LTE, IEEE 802.11ah, Discuss data rate, range, power, computations/bandwidth, QoS

d. Smartness - Signal Processing/Analytics: Impact on Power/Energy savings, dynamic networks, simple case studies

e. IoT Fabricator: Introduction to Embedded electronics, fabricating electronics, Communication Network requirements, Data processing challenges – recreation, IP/security, Challenges

f. Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android), IoT Fabricator etc. can be used.

5. The students may do will visit different websites to identify their IOT topic for the mini project.

6. The students may do survey for different application using different types of sensors for their mini project.

7. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirement for their mini project problem statement.

8. Design your own circuit board using multiple sensors etc.

9. Installation, configure and manage your sensors in such away so that they can communicate with each other.

10. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors.

11. Each group will identify the Hardware and software requirement for their mini project problem statement.

12. Create and interface using Mobile/Web to publish or remotely access the data on Internet.

13. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.

14. Each group may present their work in various project competitions and paper presentations.

15. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
4. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga

References:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, Daniel Minoli John Wiley & Sons
3. Contiki Cooja User Guide.
4. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
5. Recent research/white papers

Term Work:
Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL803	DevOps Lab	--	2	--	--	--	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL803	DevOps Lab	--	--	--	--	25	25	--	50

Lab Objectives: Students will try:

1. To understand the concept of DevOps with associated technologies and methodologies.
2. To be familiarized with Jenkins, which is used to build & test software Applications & Continuous integration in Devops environment.
3. To understand different Version Control tools like GIT, CVS or Mercurial
4. To understand Docker to build, ship and run containerized images
5. To use Docker to deploy and manage Software applications running on Container.
6. To be familiarized with concept of Software Configuration Management & provisioning using tools like Puppet,Chef, Ansible or Saltstack.

Lab Outcomes: Students will be able to:

1. Remember the importance of DevOps tools used in software development life cycle
2. Understand the importance of Jenkins to Build, Deploy and Test Software Applications
3. Examine the different Version Control strategies
4. Analyze & Illustrate the Containerization of OS images and deployment of applications over Docker
5. Summarize the importance of Software Configuration Management in DevOps
6. Synthesize the provisioning using Chef/Puppet/Ansible or Saltstack.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration	1. Windows or Linux Desktop OS for Client machines	1. Internet Connection for each PC with at least 2 MBPS

1. Intel Core i3/i5/i7 Processor with Intel VT-X support 2. 4 GB RAM 3. 500 GB Harddisk 4. Gigabit Ethernet (GbE) network interface card (NIC)	2. CentOS/Fedora/Ubuntu/Redhat Server OS for One Server 3. JDK 1.8 or higher 4. Netbeans or Eclipse 5. OpenSSH	bandwidth.

Prerequisite Subjects: Operating System, Virtualization, Cloud Computing, Java and Web Programming, and Software Engineering.

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	To Understand the Concept of DevOps with related technologies which are used to Code, Build, Test, Configure & Monitor the Software Applications.	02	--
I	Build & Test Applications with Continuous Integration	To Install and Configure Jenkins to test, and deploy Java or Web Applications using Netbeans or eclipse.	04	LO 1 LO2
II	Version Control	To Perform Version Control on websites/ Softwares using different Version control tools like RCS/ CVS/GIT/Mercurial (Any two)	04	LO 1 LO 3
III	Virtualization & Containerization	To Install and Configure Docker for creating Containers of different Operating System Images	04	LO 1 LO 4
IV	Virtualization & Containerization	To Build, deploy and manage web or Java application on Docker	04	LO 1 LO 4
V	Software Configuration Management	To install and configure Software Configuration Management using Chef/Puppet/Ansible or Saltstack.	04	LO 1 LO 5

VI	Provisioning	To Perform Software Configuration Management and provisioning using Chef/Puppet/Ansible or Saltstack.	04	LO 1 LO 6

Text Books:

1. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
2. Len Bass,Ingo Weber,Liming Zhu,"DevOps, A Software Architects Perspective", Addison-Wesley-Pearson Publication.
3. John Ferguson Smart,"Jenkins, The Definitive Guide", O'Reilly Publication.
4. Learn to Master DevOps by Star EduSolutions.

References:

1. Sanjeev Sharma and Bernie Coyne,"DevOps for Dummies", Wiley Publication
2. Httermann, Michael, "DevOps for Developers",Apress Publication.
3. Joakim Verona, "Practical DevOps",Pack publication

Term Work:
Term Work shall consist of experiment on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL804	R Programming Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of two Tests					
ITL804	R Programming Lab	--	--	--	--	25	25	--	50

Lab Objectives: Students will try:

1. To provide an overview of a new language R used for data science.
2. To introduce students to the R programming environment and related eco-system and thus provide them with an in-demand skill-set, in both the research and business environments
3. To introduce the extended R ecosystem of libraries and packages
4. To demonstrate usage of as standard Programming Language.
5. To familiarize students with how various statistics like mean median etc. can be collected for data exploration in R
6. To enable students to use R to conduct analytics on large real life datasets.

Lab Outcomes: students will be able to:

1. Install and use R for simple programming tasks.
2. Extend the functionality of R by using add-on packages
3. Extract data from files and other sources and perform various data manipulation tasks on them.
4. Code statistical functions in R.
5. Use R Graphics and Tables to visualize results of various statistical operations on data .
6. Apply the knowledge of R gained to data Analytics for real life applications.

SOFTWARE requirements:

1. The R statistical software program. Available from: https://www.r-project.org/

2. RStudio an Integrated Development Environment (IDE) for R. Available from: https://www.rstudio.com/

Detailed syllabus:

Module	Detailed Content	Hours	LO Mapping
0	**Prerequisites -** Any programming Language like Java Python. Basic statistics. Data Mining Algorithms	--	--
I	**Introduction:** Installing R on personal machines. installing R and RStudio. • The basic functionality of R will be demonstrated, Variable types in R. Numeric variables, strings and factors. • Accessing the help system. Retrieving R packages. • Basic data types and operations: numbers, characters and composites. • Data entry and exporting data	02	**LO 1, LO 2, LO 3**
II	**Data structures**: vectors, matrices, lists and data frames.	04	**LO1, LO 3**
III	**R as a programming language**: • Grouping, loops and conditional execution, Functions **Exploratory data analysis** • Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot	04	**LO 1, LO 4**
IV	**Graphics in R** • Graphics and tables • Working with larger datasets • Building tables with aggregate • Introduction to ggplot2 graphics	06	**LO 3**
V	**Regression and correlation** • Simple regression and correlation, Multiple regression • Tabular data and analysis of Categorical data	02	**LO 4**
VI	**R for Data Science (Mini Project)** Implementing a mini project using any data mining or big data analytics algorithm in R • Extracting data from a large Dataset • Exploratory analysis • Using Mining algorithm • Visualizations and interpretation of results	06	**LO 5, LO 6**

Text Books:

1. URL: https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf (Online Resources)
2. R Cookbook Paperback – 2011 by Teetor Paul O Reilly Publications
3. Beginning R: The Statistical Programming Language by Dr. Mark Gardener, Wiley Publications
4. R Programming For Dummies by Joris Meys Andrie de Vries, Wiley Publications

References:

1. Hands-On Programming with R by Grolemund, O Reilly Publications
2. R for Everyone: Advanced Analytics and Graphics, 1e by Lander, Pearson Ltd.
3. R for Data Science Learning Dan Toomey December 2014 Packt Publishing Limited

Term Work:
Term Work shall consist of experiment on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM805	Project-II	--	16	--	--	8	--	8

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITM805	Project-II	--	--	--	--	100	--	50	150

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students
2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.
3. Department has to allocate 1 day in VII semester and 2 day in VIII semester every week.
4. Students will do literature survey in Sem VI or Sem VII.
5. Students will do design, implementation and coding in Sem VII.
6. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.
7. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.
8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) embers as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.
9. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.
10. Students will do testing and analyze in Sem VIII
11. Teams must analyze all the results obtained by comparing with other standard techniques.
12. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.
2. Each team will prepare a report that will summarize the results of the literature survey and implementation and coding as project proposal in SEM VII. The list of papers surveyed must be clearly documented.
3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.
4. Oral exam will be conduct on the project done by the students.

Term Work:

Term Work shall consist of full Project-I on above guidelines/syllabus.

Term Work Marks: 100 Marks (Total marks) = 95 Marks (Project-II) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Project-II and Presentation.

Course code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8041	User Interaction Design	04	--	--	04	--	--	04

Course code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO8041	User Interaction Design	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1 To stress the importance of good interface design.
2 To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.
3 To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.
4 To learn the techniques for prototyping and evaluating user experiences.
5 To understand interaction design process.
6 To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.

Course Outcomes:

1. Students will be able to identify and criticize bad features of interface designs.
2. Students will be able to predict good features of interface designs.
3. Students will be able to illustrate and analyze user needs and formulate user design specifications.
4. Students will be able to interpret and evaluate the data collected during the process.
5. Students will be able to evaluate designs based on theoretical frameworks and methodological approaches.
6. Students will be able to produce/show better techniques to improve the user interaction design interfaces.

Prerequisite: Web technologies, Software Engineering, Experiences in designing interfaces for applications and web sites. Basic Knowledge of designing tools and languages like HTML , Java etc.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering concepts and any programming Language	02	--
I	Introduction to Interaction Design	Good and Poor Design, What is Interaction Design, The User Experience, The Process Of Interaction Design, Interaction Design and the User Experience	**09**	**CO1,CO 2**
II	Understanding and Conceptualizing Interaction Cognitive aspects and Social, Emotional Interaction	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types Cognitive aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies	**09**	**CO2,CO 3**
III	Data Gathering, Establishing Requirements, Analysis, Interpretation and Presentation	Establishing Requirements, Five Key Issues, Techniques for Data Gathering, Data Analysis Interpretation and Presentation, Task Description and Task Analysis	**09**	**CO4**
IV	Process of Interaction Design, Prototyping, Construction,	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies	**09**	**CO4**
V	Design rules and Industry standards	Design principles, Principles to support Usability, Standards and Guidelines, Golden rules and Heuristics, ISO/IEC standards	**08**	**CO5**
VI	Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, case studies, DECIDE Framework, Usability Testing, conducting	**06**	**CO5,CO 6**

		experiments, Field studies, Heuristic Evaluation and walkthroughs, Predictive models.		

Text Books:

1. *Interaction Design*, by J. Preece, Y. Rogers and H. Sharp. ISBN 0-471-49278-7.
2. *Human Computer Interaction, by Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale*
3. Alan Cooper, Robert Reimann, David Cronin, "About Face3: Essentials of Interaction design", Wiley publication.
4. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication.

References:

1. The UX Book, by Rex Hartson and Pardha S Pyla.
2. Donald A. Norman, "The design of everyday things", Basic books.
3. Jeff Johnson, "Designing with the mind in mind", Morgan Kaufmann Publication.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8042	Information Retrieval System	04	--	--	04	--	--	04

Course Code	CourseName	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of twoTests					
ITDLO8042	Information Retrieval System	20	20	20	80	--	--	--	100

Course Objectives: students will try:

1. To learn the fundamentals of information retrieval system.
2. To classify various Information retrieval models.
3. To demonstrate the query processing techniques and operations
4. To compare the relevance of query languages for text and multimedia data
5. To evaluate the significance of various indexing and searching techniques for information retrieval.
6. To develop a effective user interface for information retrieval.

Course Outcomes:

1. Students will define and describe the objectives the basic concepts of Information retrieval system.
2. Students will evaluate the taxonomy of different information retrieval models.
3. Students will solve and process text and multimedia retrieval queries and their operations
4. Students will evaluate text processing techniques and operations in information retrieval system.
5. Students will demonstrate and evaluate various indexing and searching techniques.
6. Student will design the user interface for an information retrieval system.

Prerequisite: Data structures and algorithms

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Comment (Prerequisite syllabus should not be considered for paper setting) Indexing and searching Algorithms	02	
I	Introduction	Motivation, Basic Concepts, The retrieval Process, Information System: Components, parts and types on information system; Definition and objectives on information retrieval system	05	CO1
II	IR Models	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Adhoc and filtering, Formal Characteristics of IR models, Classic Information Retrieval, Alternative Set Theoretic models, Probabilistic Models, Structured text retrieval Models, models for Browsing; Multimedia IR models: Data Modeling	09	CO2
III	Query Processing and Operations	Query Languages: Keyword based Querying, Pattern Matching, Structural Queries, Query Protocols; Query Operations: User relevance feedback, Automatic local analysis, Automatic global analysis, Multimedia IR Query Languages	10	CO3
IV	Text Processing	Text and Multimedia languages and properties: Metadata, Markup Languages, Multimedia; Text Operations: Document Preprocessing, Document Clustering, Text Compression, Comparing Text Comparison Technique	10	CO4
V	Indexing and Searching	Inverted files, Other indices for text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression; Multimedia IR: Indexing and Searching:- Spatial Access Methods, A Generic Multimedia indexing approach, One-	11	CO5

		dimensional time series, Two dimensional color images, Automatic Feature extraction; Searching Web: Challenges, Characterizing the web, Search Engines. Browsing, Meta searches, Searching needle in haystack, Searching using Hyperlinks		
VI	User interface and visualization	Human Computer interaction, the information access process, starting points, query specifications, context, using relevance judgments, interface support for the search process	05	CO6

Text Books:

1.Modern Information Retrieval, Ricardo Baeza-Yates,berthier Ribeiro- Neto, ACM Press- Addison Wesley
2. Information Retrieval Systems: Theory and Implementation, Gerald Kowaski, Kluwer Academic Publisher
3. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India

References:

1. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press
2. Information Storage & Retieval By Robert Korfhage – John Wiley & Sons
3. Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8043	Knowledge Management	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO8043	Knowledge Management	20	20	20	80	--	--	--	100

Course Objectives:

1 Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits, and guiding principles on which to build greater understanding of knowledge management

2 Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.

3 Increase information and understanding about knowledge transfer using low- and high technology strategies

4 Explore the future of knowledge management and its influence on our jobs, communities, and society

Course Outcomes: After completion of the course the learner will be able to

1) Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.
2) Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems
3) Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.
4) Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy Ponder KM's current and future impact on individuals, organizations and society at large

Prerequisite: An introductory course in IT/ IS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge - Subjective & Objective views of knowledge, procedural Vs. Declarative, tacit Vs. explicit, general Vs. specific.	**3**
I	Introduction to Knowledge Management	What is Knowledge? Types of expertise – associational, motor skill,¬ theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role Relevance of KM in today's dynamic & complex environment Future of Knowledge Management	**5**
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation. Knowledge Architecture.	**8**
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory Grid- Concept Mapping –Blackboarding, Nominal Group Technique, Delphi method,	**9**
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer's Skill Sets – System Testing and Deployment – Knowledge Testing – Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation.	**9**
V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers.	**9**

VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures Identification of appropriate KM solutions, Ethical Legal and Managerial Issues	**9**

Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies . Prentice Hall. ISBN: 0-13-109931-0.
2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13-034820-1
3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).
4. Shelda Debowski, Knowledge Management, Wiley India Edition.

References:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.
2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.
3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.
4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8044	Robotics	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO8044	Robotics	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. Learn the basic concepts of Robots.
2. Learn the concepts of Kinematics of Robotics.
3. Learn the concepts of Motions, velocities and dynamic analysis of force.
4. Learn the concepts of Motion planning.
5. Learn the concepts of Trajectory Planning
6. Learn the concepts of Potential Functions, Visibility Graphs and Coverage Planning

Course Outcomes: Student will be able to:

1. Apply the basic concepts of Robots.
2. Apply and evaluate the concepts of Kinematics of Robotics.
3. Apply the Motions, velocities and dynamic analysis of force.
4. Apply and evaluate Motion planning.
5. Apply the concepts of Trajectory Planning
6. Apply the concepts of Potential Functions, Visibility Graphs and Coverage Planning

Prerequisites: Basic of Electrical Engineering.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisites**	Basics of Electrical Engineering	02	--
I	Fundamentals	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate	04	CO1

		frames, workspace, applications		
II	Kinematics of Robotics	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation, Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	11	CO2
III	Motions, velocities and dynamic analysis of force	Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian. Lagrangian mechanics, Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames	09	CO3
IV	Trajectory Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories	08	CO5
V	Motion Planning	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	04	CO4
VI	Potential Functions, Visibility Graphs and Coverage Planning	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods. Cell Decomposition, Localization and Mapping	14	CO6

Text Books:

1. Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011

2. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, “Principles of Robot Motion –Theory, Algorithms and Implementations”, Prentice-Hall of India

References:

1. Mark W. Spong & M. Vidyasagar, “Robot Dynamics & Control”, Wiley India Pvt. Ltd., Second Edition, 2004
2. John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
3. Aaron Martinez & Enrique Fernandez, “Learning ROS for Robotics Programming”, Shroff Publishers, First Edition, 2013.

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8045	Enterprise Resource Planning	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO8045	Enterprise Resource Planning	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To learn the basic concepts of ERP.
2. To learn different technologies used in ERP.
3. To learn the concepts of ERP Manufacturing Perspective and ERP Modules.
4. To learn what are the benefits of ERP
5. To study and understand the ERP life cycle.
6. To learn the different tools used in ERP.

Course Outcomes: Student will be able to:

1. Understand the basic concepts of ERP.
2. Identify different technologies used in ERP.
3. Understand and apply the concepts of ERP Manufacturing Perspective and ERP Modules.
4. Discuss the benefits of ERP
5. Understand and implement the ERP life cycle.
6. Apply different tools used in ERP.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basics of software.	02	--
I	Introduction to ERP	Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model	04	CO1

II	ERP Technologies	Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System	06	CO2
III	ERP Manufacturing Perspective and ERP Modules	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP – Distributed Requirement Planning, PDM - Product Data Management. Finance, Plant Maintenance, Quality Management, Materials Management.	10	CO3
IV	Benefits of ERP	Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability	08	CO4
V	ERP Life cycle	Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode).	06	CO5
VI	E-Commerce to E-business	E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real world, ERP Implementation, Future of ERP applications, memo to CEO ,E-Procurement, E- Governance, Developing the E-Business Design.	16	CO6

		JD Edwards-Enterprise One. Microsoft Dynamics-CRM Module.		

Text Books:

1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill.
2. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.
3. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.

References:

1. Guide to Planning ERP Application, Annetta Clewwto and Dane Franklin, McGRaw-Hill, 1997
2. The SAP R/3 Handbook, Jose Antonio, McGraw – Hill
3. E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A Practical Roadmap For Success By Dr. Ravi Kalakota

Assessment:

Internal Assessment for 20 marks:
Consisting of **Two Compulsory Class Tests**
Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions**, **each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting,	8

	engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	10

	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8023	Enterpreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and	6

	stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data	**08**

	j. Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement	07

	Patent databases: Important websites, Searching international databases	

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

AC 14/7/2016

Item No. 4.23

UNIVERSITY OF MUMBAI

Revised Syllabus

For

Master of Engineering

Program: M. E. (Information Technology)
Revised 2016

Under

FACULTY OF TECHNOLOGY

(As per Choice Based Credit and Grading System with effect from the academic year 2016–2017)

From Co-ordinator's Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. S. K. Ukarande

Co-ordinator,

Faculty of Technology,

Member - Academic Council

University of Mumbai, Mumbai

Preamble

It is an honor and a privilege to present the revised syllabus of Master of Engineering in Information Technology (effective from year 2016-17) with inclusion of cutting edge technology.
Information Technology is comparatively a young branch among other engineering disciplines in University of Mumbai. It is evident from the placement statistics of various colleges affiliated to University of Mumbai that IT branch has taken the lead in the placement. The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions.
It has been observed that graduate engineers having work experience in IT industry would prefer to pursue their post graduate studies in IT in spite of having done their graduation degree in any branch .
Keeping these aspects in mind, University of Mumbai has designed postgraduate courses as per current requirements of IT industry.
The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.
I would like to thank senior faculties of IT department of all colleges affiliated to Mumbai University for significant contribution in framing the syllabus. Also behalf of all faculties I thank all the industry experts for their valuable feedback and suggestions.
I sincerely hope that the revised syllabus will help all post graduate engineers to face the future challenges in the field of information and technology

Program Outcome for Postgraduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology management and security to enterprise processes.
3. Manage IT projects using written and oral communication skills in collaborative environments by Participating on teams that address solutions for IT management challenges.
4. Identify and discuss professional, individual, organizational, societal, and regulatory implications of Information systems and technology.
5. Assess Security of the IT Systems and able to respond to any breach in IT system
6. Ability to work in multidisciplinary projects and make it IT enabled.
7. Ability to propose the system to reduce carbon footprint.
8. Ability to adapt the lifelong learning process to be in sync with trends in Information Technology

Dr. Deven Shah

Chairman (Ad-hoc Board Information Technology)

University of Mumbai)

Program Structure for
ME Information Technology
Mumbai University
(With Effect from 2016-2017)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEITC101	Data Science	04	--	--	04	--	--	04
MEITC102	IT Infrastructure Design	04	--	--	04	--	--	04
MEITC103	Advances in Software Engineering	04	--	--	04	--	--	04
MEITDLO-I	Department Level Optional Course-I	04	--	--	04	--	--	04
ILO-I	Institute Level Optional Course-I	03	--	--	03	--	--	03
MEITL101	Laboratory-I	--	02	--	--	01	--	01
MEITL102	Laboratory-II	--	02	--	--	01	--	01
Total		**19**	**04**	**--**	**19**	**02**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract./ oral	Total
		Internal Assessment			End Sem.Exam.	Exam Duration (hrs)			
		Test1	Test 2	Avg.					
MEITC101	Data Science	20	20	20	80	3	--	--	100
MEITC102	IT Infrastructure Design	20	20	20	80	3	--	--	100
MEITC103	Advances in Software Engineering	20	20	20	80	3	--	--	100
MEITDLO-I	Department Level Optional Course-I	20	20	20	80	3	--	--	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	--	100
MEITL101	Laboratory-I	--	--	--	--		25	25	50
MEITL102	Laboratory-II	--	--	--	--		25	25	50
Total		**100**	**100**	**100**	**400**		**50**	**50**	**600**

 # Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester I and Semester II, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester I			
MEITDLO1011	User Experience Engineering	ILO1011	Product Lifecycle Management
MEITDLO1012	Adhoc Networks	ILO1012	Reliability Engineering
MEITDLO1013	Cloud Computing	ILO1013	Management Information System
MEITDLO1014	IT Strategy	ILO1014	Design of Experiments
MEITDLO1015	Knowledge Management	ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management and Mitigation Measures
		ILO1018	Energy Audit and Management

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEITC201	Security & Risk Management	04	--	--	04	--	--	04
MEITC202	High Performance Computing	04	--	--	04	--	--	04
MEITC203	Advance web technology	04	--	--	04	--	--	04
MEITDLO-II	Department Level Optional Course-I	04	--	--	04	--	--	04
ILO-II	Institute Level Optional Course-I	03	--	--	03	--	--	03
MEITL201	Laboratory-III	--	02	--	--	01	--	01
MEITL202	Laboratory-IV	--	02	--	--	01	--	01
Total		**19**	**04**	**--**	**19**	**02**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem.Exam.	Exam Duration (hrs)	Term Work	Pract./ oral	Total
		Test1	Test 2	Avg.					
MEITC201	Security & Risk Management	20	20	20	80	3	--	--	100
MEITC202	High Performance Computing	20	20	20	80	3	--	--	100
MEITC203	Advance web technology	20	20	20	80	3	--	--	100
ME-ITDLO-II	Department Level Optional Course-I	20	20	20	80	3	--	--	100
ILO-II	Institute Level Optional Course-I	20	20	20	80	3	--	--	100
MEITL201	Laboratory-III	--	--	--	--		25	25	50
MEITL202	Laboratory-IV	--	--	--	--		25	25	50
Total		**100**	**100**	**100**	**400**		**50**	**50**	**600**

 # Department Level Optional Course (DLO)

Every student is required to take one Department Level Optional Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Level Optional Course for Semester I and Semester II, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester II			
MEITDLO2021	E-Business & Social Network Analysis	ILO2021	Project Management
MEITDLO2022	AI & Machine Learning	ILO2022	Finance Management
MEITDLO2023	Ethical Hacking & Forensic	ILO2023	Entrepreneurship Development and Management
MEITDLO2024	Internet of Things	ILO2024	Human Resource Management
MEITDLO2025	Advanced Software Quality Assurance	ILO2025	Professional Ethics and CSR
		ILO2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEITS301	Seminar	--	06	--	--	03	--	03
MEITD301	Dissertation 1	--	24	--	--	12	--	12
Total		**--**	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory						
		Internal Assessment			End Sem.Exam.	Term Work	Oral.	Oral
		Test1	Test 2	Avg.				
MEITS301	Seminar	**--**	**--**	**--**	--	50	50	100
MEITD301	Dissertation 1	**--**	**--**	**--**	--	100	--	100
Total		**--**	**--**	**--**	**--**	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEITD401	Dissertation II	--	30	--	--	15	--	15
Total		**--**	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory						
		Internal Assessment			End Sem.Exam.	Term Work	Oral	Total
		Test1	Test 2	Avg.				
MEITD401	Dissertation II	**--**	**--**	**--**	--	100	100	200
Total		**--**	**--**	**--**	**--**	**100**	**100**	**200**

* The Term Work and Oral of Project II of Semester IV should be assessed jointly by the pair of Internal and External Examiners

Note- The Contact Hours for the calculation of load of teacher are as follows
Seminar - 01 Hour / week / student
A project I and II - 02 Hour / week / student

End Semester Examination: In all, six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Semester I

Subject Code	Subject Name	Credits
MEITC101	**Data Science**	**04**

Course Objectives:

- Provide Insights about the Roles of a Data Scientist and enable to analyze the Big Data.
- Understand the principles of Data Science for the data analysis and learn cutting edge tools and techniques for data analysis.
- Figure Out Machine Learning Algorithms.
- Learn business decision making and Data Visualization

Course Outcomes:

The student should be able:

- Demonstrate knowledge of statistical and exploratory data analysis data analysis techniques utilized in decision making.
- Apply principles of Data Science to the analysis of business problems.
- To use Machine Learning Algorithms to solve real-world problems.
- To provide data science solution to business problems and visualization.

Prerequisite: fundamentals of data base, basic programming skills

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Relational database, KDD process, Introduction to BIG data, What is Hadoop, Core components of Hadoop, Hadoop ecosystem.	**3**
I	An Introduction to Data Science	Definition, working, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist,	**4**
II	Statistical Data Analysis & Inference	Populations and samples, Statistical modeling, probability distributions, fittings a model, Statistical methods for evaluation, Exploratory Data Analysis, Getting started with R, Manipulating and Processing data in R , working with function in R , Working with descriptive Statistics, Working with graph plot in R.	**8**
III	Learning Algorithms	k-nearest neighbor, Simple and multiple Linear Regression, Logistic Regression, Support vector machine, Model-Based Clustering, Clustering High-Dimensional Data,	**12**
IV	Data Visualization	Data Visualization basics, techniques, types, applications, tools, Data Journalism, Interactive dashboards,	**8**
V	Advance Analytical Methods	Text Analysis- Text analysis steps, A text analysis example, Collecting raw text and representing text, TF and TFIDF, Categorizing documents by topics, determining	**8**

		sentiments, Time series analytics- overview, ARIMA model,	
VI	Business problems and data science solutions	Data Science and Business Strategy: Thinking Data-Analytically, Redux, Competitive Advantage with Data Science, Data Science Case Studies, Case Study: Global Innovation Network and Analysis.	**5**

Text Books:

1. Data science and big data analytics, EMC

2. Doing Data Science, *Rachel Schutt and Cathy O'Neil*

3. Introducing Data Science, Davy Cielen

4. Data Science for Business, Foster Provost and Tom Fawcett, O'Reilly. Copyright © 2013

References:

1. Regression Analysis by Example,

2. Data Mining Concepts and Techniques, Third Edition, Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann

3. An Introduction to Statistical Learning with Applications in R , Gareth James • Daniela Witten • Trevor Hastie, Robert Tibshirani, Springer

List of Experiments : based on Laboratory Practical's/ Case studies

1. Exploratory Data Analysis and regression using R.

2. Text Analysis using R

3. Business problem : Data science solution.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of the end semester examination.

Subject Code	Subject Name	Credits
MEITC102	**IT Infrastructure Design**	**04**

Course Objective:

- Provide knowledge of Enterprise wide Network Design.
- Provide Knowledge of Data center design includes Storage network
- Give insight into the implementation of SDN and how it will impact current Design practice
- Understand latest trend in SDN

Course Outcome: Students should be able to

- Design Enterprise wide network design considering various QoS Parameter
- Explain the design challenge of large scale data center
- Implementation of SDN and how it will impact current Design practice
- explain latest trend in SDN

Prerequisite: Basic knowledge of Networking techniques.

Module	Detailed content	Hours
Prerequisite	- Basic of Networking Topology - OSI Layer Basics - Basics of Internetworking Devices	3
I	Enterprise Network Design: Understanding Network Requirement analysis, Architecture and Design Process Network Architecture: Component Architecture –Routing, Network Management, Performance, Security. Architectural models: topological, flow model, Functional model Addressing And Routing Architecture, Network Management Architecture, Performance Architecture Border less Network Architecture. Network Design: Designing the network topology and solutions-Top Down Approach Network Structure Model: Hierarchical Network Model, Enterprise wide network Architecture model- Enterprise Edge Area. E-commerce, Internet Connectivity to remote, enterprise branch and enterprise Data center module. High Availability Network Services- Workstation to Router redundancy and LAN High Availability protocols, Route, Server Redundancy, Load Balancing., link Media Redundancy.	8
II.	Enterprise LAN Design: Ethernet Design Rule. 100 Mbps Fast Ethernet Design rules, gigabit Ethernet Design Rules, 10 Gigabit Ethernet Design rules, 10GE Media types Understanding Working of Repeater, hub, Bridge, routers, Layer2/3 Switch Campus LAN Design Best Practice Server Farm Design, DMZ design. Campus LAN QoS consideration Multicast Traffic Consideration	6
III.	Data Center Design: Architecture Consideration: Infrastructure Model, Service Layers Model of Cloud computing. Cloud Reference Architecture Framework, Cloud Data Center Building Blocks. Cloud Data Center Technology Architecture Trust in Cloud Data Center The elements of cloud visibility The elements of cloud protection Cloud Control, Compliance and SLA. Telecommunications Infrastructure Standard for Data Centers ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers ,	10

	NSI/NECA/BICSI-002 Data Center Design and Implementation Best Practices Purpose of TIA-942 Design Elements - Cabling Design, Facility Design, Network Design. Relationship of Spaces, Data Center Topology Data Center Tiers Basic Data Center Design Example.	
IV.	Enterprise Wireless LAN Architecture: Components of Centralize Architecture: understanding 802.11X standards, LWAPP WLAN Controller. WLAN technologies (Narrow Band, Spread Spectrum, FHSS, DSS) and topologies, Wireless Network Components: Access Point and NICs, Router etc; WLAN enterprise design, WLAN performance, WLAN monitoring and troubleshooting, WLAN security. Intra and inter controller roaming.	5
V.	SAN: Need for storage Network, Data Protection and RAID, Storage Network Architecture and IP storage, Storage Network Backup and Recovery, Storage and Network in Storage Network, Software for Storage Network, Adopting and Managing SAN.	7
VI.	Software Defined Network : Understanding SDN and Open Flow : SDN – Network Virtualization Techniques, SDN Building Blocks, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages, Implementing OpenFlow Switch, OpenFlow controllers , PoX and NoX, NetApp Development on top of SDN, Open Flow in Cloud Computing. Case study: how SDN changed Traditional Enterprise network Design	9

References:

1. Network Analysis, Architecture, and Design 3rd Edition, Morgan Kaufman, James D.
2. CCDA Cisco official Guide
3. Cisco Cloud Computing - Data Center Strategy, Architecture, and Solutions by Kapil Bakshi - Cisco Systems White paper
4. https://en.wikipedia.org/wiki/TIA-942
5. "Data Center Top-of-Rack Architecture Design" . *White paper*. Cisco Systems. April 18, 2011. Retrieved July 10, 2013.
6. Software Defined Networking with Open Flow : PACKT Publishing Siamak Azodolmolky
7. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India
8. Storage Networks explained by Ulf Troppen, wiley publication
9. Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs by Richard Barker, Paul Massiglia, Wiley India

List of Experiments: based on Laboratory Practical's/ Case studies

1. Design on Enterprise LAN.
2. Design on Enterprise Wireless LAN.
3. Case study on SAN and RAID.

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of the end semester examination.

Subject Code	Subject Name	Credits
MEITC103	**Advances in Software Engineering**	**04**

Course Objectives: Objectives of this course include:

1. To learn and understand the principles of Software Engineering
2. To Learn and understand Software Development Life Cycle
3. To apply Project Management and Requirement analysis principles to S/W project development..
4. To apply Design and Testing principles to S/W project development.

Course Outcomes: On successful completion of the course students will be able to

1. Compare and chose a process model for a software project development.
2. Analyze and model software requirements of a software system
3. Design and Modeling of a software system with tools
4. Prepare the SRS, Design document, Project plan of a given software system

Prerequisite: Any programming language

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Nature of Software, Software Definition, Software characteristics, Software Application Domains, Software Myths, Software Engineering Practice	**03**
I	Nature of Software	Software Engineering, The Software Process, A Generic Process Model, Prescriptive Process Models: The Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Specialized Process Models, The Formal Methods Model, The Unified Process Personal, Agility Principles , Extreme Programming (XP), Scrum, Introduction to Clean Room Software Engineering	**06**
II	Requirements Engineering	Requirements Engineering, Eliciting Requirements, Collaborative Requirements Gathering, Quality Function Deployment, Usage Scenarios, Elicitation Work Products, Developing Use Cases, Building the Requirements Model, Negotiating Requirements, Validating Requirements, Analysis: Scenario-Based Modeling, UML Models, Developing an Activity Diagram, Swim-lane Diagrams, Class-Based Modeling, Requirements Modeling Strategies: Flow Oriented Modeling, Creating a Behavioral Patterns for Requirements Modeling, State Machine Diagram with orthogonal states, Requirements Modeling for Web Apps,	**08**

		SRS	
III	Design Methods and Models	The Design Process, Concepts of design, Design Quality, Design Principles, Object-Oriented Design Concepts, Design Classes, The Design Model and elements, Software Architecture, Importance, Architectural Styles, Architectural Design, Assessing Alternative Architectural Designs, using Architectural Styles in Designs, Component Design, Class-Based Components, Conducting Component Level Design, Component-Level Design for WebApps, User Interface Design, The Golden Rules, User Interface Analysis and Design, Interface Analysis Interface Design Steps, WebApp Interface Design, Design Evaluation, Design Document, Modifiability: SAAM Method, ATAM Method, The HASARD Method.	**08**
IV	Testing Principles	Principles A Strategic Approach to Software Testing, Strategic Issues, Test Conventional Software, Test Strategies for Object-Oriented Software, Test Strategies for WebApps, Validation Testing, System Testing, The Art of Debugging, Software Testing Fundamentals, White-Box Testing , Basis Path Testing, Control Structure Testing, Black-Box Testing, Model-Based Testing, Testing for Specialized Environments, Architectures, Object-Oriented Testing Strategies, Object-Oriented Testing Methods, Test Cases and the Class Hierarchy, Testing Concepts for WebApps, Testing Process—An Overview, User Interface Testing , Test plan, Positive Testing Negative Testing	**06**
V	Project Planning and management	The Management Spectrum, Software Scope, Problem Decomposition, Process Decomposition , Process and project metrics, Size-Oriented Metrics, Function Oriented Metrics, Reconciling LOC and FP Metrics, Object-Oriented Metrics, Integrating Metrics within the Software Process, Software Project Estimation, Decomposition, Process-Based Estimation, Estimation with Use Cases, Empirical Estimation Models, The Structure of Estimation Models, The COCOMO II Model , Project scheduling: Basic Concepts, Defining a Task Set for the Software Project , Scheduling : Tracking the Schedule, Earned Value Analysis Risk management: Reactive versus Proactive Risk Strategies, Risk Identification, Assessing Overall Project Risk, Risk Projection, Developing a Risk Table, Assessing Risk, Project Plan	**11**
VI	Advanced Trends in Software Engineering	Introduction to Formal Specification Languages : Object Constraint Language (OCL), Z Specification Language, Software reuse, Distributed software engineering, Service-oriented architecture, Embedded software, Aspect-oriented software engineering, Introduction to DevOps, Docker, Github.	**06**

Text Books:

1. Roger S Pressman “Software Engineering : A Practitioner’s Approach “ 7th Edition Mcgraw-Hill ISBN:0073375977
2. Ian Sommerville “ Software Engineering” 9th edition Pearson Education SBN-13: 978-0- 13-703515-1, ISBN-10: 0-13-703515-2
3. Hong Zhu “Software Design Methodology”, Elsevier ISBN: 978-81-312-0356-9

References:

1. Pankaj Jalote " An Integrated Approach to Software Engineering" 3rd Edition Narosa Publication ISBN: 81-7319-702-4
2. Rajib Mall " Fundamentals of Software Engineering" 3rd edition PHI.
3. Pfleejer " Software Engineering- Theory and Practice" 4th edition
4. Martin Fowler "Distilled UML" 3rd edition Stephen H. Kan, "Metrics and Models in Software Quality Engineering", 2nd Edition, Pearson, 2003
5. 5. Hans Van Vilet "Software Engineering Principles and Practice" 3rd edition Wiley
6. Devops.com

List of Experiments: based on Laboratory Practical's

1. Introduction to DevOps, Docker, Github (The tools can be used to implement practical)
2. Technical paper reading. Student will read any technical paper in software engineering and explain its contents to the class.
3. Development of one software project with following deliverables
    a. Analysis Model
    b. Design Model
    c. Working application
    d. Test case Design
    e. RMMM plan

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO1011	**User Experience Engineering**	**04**

Course Objectives :

1 To stress the importance of a User Experience Engineering (UXE).
2 To Learn User Experience Engineering (UXE) Process.
3 To understand how to design Effective and Efficient User Interfaces for intended users.
4 To Learn techquies for Prototyping and Evaluating User Experiences.

Course Outcomes:

1 Understand importance of User Experience (UX).
2 Gain and apply knowledge of the theoretical frameworks, methodological approaches, and problems solving techniques related to user experience design.
3 Criticize existing interface designs, and improve them.
4 Design complete application with end-to-end understanding of current UXE best practices and processes.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc.

"User experience engineering (UXE)" -describe a structured research, design, and evaluation process whose goal is to make user interactions with a product or service easy, efficient, and enjoyable. It evolved from usability engineering and applies psychological principles and methodologies.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Pre-requisites	HCI and Usability, Usability Paradigms and Usability Principles, User Interface Design Tools.	3
I	Introduction	What is UX, Ubiquitous interaction, Emerging desire for usability, From usability to user experience, Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.	6
II	The Wheel: A Lifecycle Template	Introduction, A UX process lifecycle template, Choosing a process instance for your project, The system complexity space, Meet the user interface team, Scope of UX presence within the team, More about UX lifecycles.	6
III	Contextual Inquiry: Eliciting Work Activity Data	Introduction, The system concept statement, User work activity gathering, Look for emotional aspects of work practice, Abridged contextual inquiry process, Data-driven vs. model-driven inquiry, History. ,Contextual Analysis, Extracting Interaction Design Requirements, Constructing Design-Information Models.	10
IV	Design Thinking, Ideation, and Sketching, Prototyping	Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation, Sketching, More about phenomenology, Mental Models and Conceptual Design, Wireframe, Prototyping	10
V	UX Evaluation, The Interaction	UX Goals, Metrics and Targets, UX Evaluation Techniques.-Formative vs summative ,Analysis.	8

	Cycle and the User Action Framework	Introduction, The interaction cycle, The user action framework—adding a structured knowledge base to the interaction cycle, Interaction cycle and user action framework content categories, Role of affordances within the UAF, Practical value of the UAF.	
VI	UX Design Guidelines	Introduction, Using and interpreting design guidelines, Human memory limitations, Selected UX design guidelines and examples, Planning, Translation, Physical actions, Outcomes, Assessment, Overall.	5

Text Books:

1. The UX Book by Rex Hartson and Pardha Pyla

2. Smashing UX Design by Jesmond Allen and James Chudley

3. Lean UX: Applying Lean Principles to Improve User Experience by Jeff Gothelf and Josh Seiden

4. Don't Make Me Think, Revisited by Steve Krug

5. The User Experience Team of One by Leah Buley

6. The Elements of User Experience by Jesse James Garrett

7. Sketching User Experiences: The Workbook by Saul Greenberg, Sheelagh Carpendale, Nicolai Marquardt and Bill Buxton

References:

1. A Project Guide to UX Design by Russ Unger and Carolyn Chandler

2. Agile Experience Design by Lindsay Ratcliffe and Marc McNeill

3. Universal Principles of Design by William Lidwell, Kritina Holden and Jill Butler

4. Human Computer Interaction by Alan Dix

Lab Practical's: For any Case Study perform following practicals:-

Sr.No. Description

1. **Indentify and describe the objectives for UXE project-**
    a. Perform user research
    b. User requirement collection
    c. User Requirement Analysis
    d. Create User personas, user scenarios , customer journey maps etc
2. **UX Design –**
    a. Conceptual Design- Site Maps
    b. Create Wireframe
    c. Create Prototype
3. **UX Evaluation**

a. Set UX Goals

b. Perform UX Evaluation and Reporting

Assessment:

Term work consists of any two case studies or mini project covering the above syllabus.

Internal : Internal assessment will be of **20** marks .Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Theory paper will be of **80** marks. Some guidelines for setting the question Papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO1012	**Ad-hoc Networks**	**04**

Course Objectives:

1. Understand the basic concepts of ad-hoc networks

2. Explain the basics of mobile telecommunication system

3. Be familiar with network protocol stack

4. Gain knowledge of different mobile platforms and application development

Course Outcomes:

1. Explain the basic concepts of ad-hoc networks

2. Explain the basics of mobile telecommunication system

3. Identify the network protocol stack

4. Develop different mobile application using different platform.

Prerequisite: Network, Operating System, Wireless Technology

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite:	Introduction – Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio Propagation Mechanisms.	**3**
I	**Introduction**	Wireless Network. Characteristics of the Wireless channel. Cellular and Ad-Hoc Wireless Networks, Applications of Ad-Hoc Wireless Networks/MANET/Wireless Sensor Network/VANET. Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Mobility, Hidden and Exposed terminal Problems, Characteristics of an Ideal Routing Protocol for Ad-Hoc Wireless Networks	**7**
II	**Medium access protocols**	MAC Protocols: design issues, goals and classification. Contention based protocols- with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.11p, 802.15. HIPER LAN	**8**
III	**Ad hoc routing protocols**	Introduction – Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks – Classifications of Routing Protocols – Table–Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV) – Wireless Routing Protocol (WRP) – Cluster Switch Gateway Routing (CSGR) – Source–Initiated On–Demand Approaches – Ad hoc On–Demand Distance Vector Routing (AODV) – Dynamic Source Routing (DSR) –Temporally Ordered Routing Algorithm (TORA) – Signal Stability Routing (SSR) – Location–Aided Routing (LAR) – Power–Aware Routing	**8**

		(PAR) – Zone Routing Protocol (ZRP).	
IV	**Multicast routing in ad-hoc networks**	Introduction – Issues in Designing a Multicast Routing Protocol – Operation of Multicast Routing Protocols – An Architecture Reference Model for Multicast Routing Protocols –Classifications of Multicast Routing Protocols – Tree–Based Multicast Routing Protocols– Mesh–Based Multicast Routing Protocols – Summary of Tree and Mesh based Protocols – Energy–Efficient Multicasting – Multicasting with Quality of Service Guarantees – Application – Dependent Multicast Routing – Comparisons of Multicast Routing Protocols.	**8**
V	**Transport layer– security protocols**	Introduction – Issues in Designing a Transport Layer Protocol for Ad hoc Wireless Networks – Design Goals of a Transport Layer Protocol for Ad hoc Wireless Networks – Classification of Transport Layer Solutions – TCP over Ad hoc Wireless Networks – Other Transport Layer Protocols for Ad hoc Wireless Networks – Security in Ad Hoc Wireless Networks – Network Security Requirements – Issues and Challenges in Security Provisioning – Network Security Attacks – Key Management – Secure Routing in Ad hoc Wireless Networks.	**8**
VI	**Mobile/vehicular Ad-hoc Networks**	MANET, VANET, Design issues, Routing, MANET vs VANET, Various Attacks on MANET/VANET, Attacks on Routing Mechanisms, Security Mechanisms in the Network Layer, Security Mechanisms in the Data - Link Layer, Key Management.	**6**

Text book

1. S. Sarkar, T. Basavraju and C. Puttamdappa, “Ad hoc mobile wireless networks principles, protocols and applications” , second edition, CRC Press, 2016.
2. Al-Sakib Khan Pathan, Muhammad Mostafa Monowar, Zubair Md. Fadlullah, “Building Next-Generation Converged Networks: Theory and Practice, CRC Press, 2013.
3. Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic, “Mobile Ad Hoc Networking: The Cutting Edge Directions”, John Wiley 2013.
4. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007

References

1. C. K. Toh, “Ad Hoc Mobile Wireless Networks Protocols and Systems”, Prentice Hall, PTR, 2001.
2. Charles E. Perkins, “Ad Hoc Networking”, Addison Wesley, 2000
3. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004
4. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005

Practical

1. Implement Ad-hoc network using BlueHoc Simulator.
2. Implement MANET using DARS Simulator.
3. Implement simple VANET/WSN using NS2.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO1013	**Cloud Computing**	**04**

Course Objectives:

1. Introduce the broad perceptive of cloud architecture and model

2. Able to set up private cloud

3. Understand the Business Aspects of Mobile Cloud Computing

4. Understands research challenges in mobile cloud computing systems

Course Outcomes:

1) Apply suitable virtualization concept
2) Design cloud services
3) Design various applications by integrating cloud services using mobile cloud
4) Apply the concepts of mobile cloud computing for implementing mobile cloud applications

Prerequisite: Mobile Computing, Cloud Computing

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite:	Mobile Computing**,** Generations of Mobile Communication, Mobile architecture, Mobile Operating Systems, Applications of Mobile Communication, Challenges of Mobile Communication, Cloud Computing**,** Cloud Computing Architecture, Cloud Computing Deployment Models, Issues of Cloud Computing.	**3**
I	**Cloud Computing**	Virtualization Techniques, Cloud Infrastructure , Architecture Design of Compute and Storage Clouds, Design challenges-Inter Cloud Resource Management, Resource Provisioning and Platform Deployment, Cloud Sim Simulator	**7**
II	**Mobile Cloud Computing**	Introduction, Motivation to Mobile Cloud Computing, Architecture of Mobile Cloud Computing, Platform and Technologies, Mobile Augmentation Approaches, Issues of Mobile Cloud Computing, Advantages of Mobile Cloud Computing, Applications of Mobile Cloud computing, Research Challenges in Mobile Cloud Computing	**8**
III	**Offloading in Mobile Cloud Computing**	Introduction, Offloading Decision, Types of Offloading, Topologies of Offloading, Offloading in Cloud Computing and in Mobile Cloud Computing: Similarities and Differences, Adaptive Computation Offloading from Mobile Devices, Cloud Path Selection for Offloading, Mobile Data Offloading Using Opportunistic Communication, Three-Tier Architecture of Mobile Cloud Computing, Requirements of Data Offloading, Performance Analysis of Offloading TechniquesMulti-Cloud Offloading in Mobile Cloud Computing Environment	**8**

IV	**Green Mobile Cloud Computing**	Introduction, Green Mobile Computing, Green Mobile Network, Green Cloud Computing, Green Mobile Cloud Computing, Green Mobile Devices Using Mobile Cloud Computing, Green Femtocell Using Mobile Cloud Computing, Green Seamless Service Provisioning with Mobile Cloud Computing, Green Location Sensing within Mobile Cloud Computing Environment	**8**
V	**Resource Allocation and Business Aspects of Mobile Cloud Computing**	Significance of Resource Allocation in Mobile Cloud Computing, Resource-Allocation Strategies in Mobile Cloud Computing, Research Challenges in Resource Allocation in Mobile Cloud Computing. Cloud Business Models, Business Model of Mobile Computing Environment, Cooperation among Service Providers, Weblet-Based Mobile Cloud Computing Model, Mobile Cloud Service Insurance Brokerage, Business Aspects of Social Mobile Cloud Computing	**6**
VI	**Application of Mobile Cloud Computing and Future Research Scope of Mobile Cloud Computing**	Introduction, Cloud Mobile Media Application, Biometric Application, Vehicle Monitoring, Mobile Learning, Application in Social Cloud, Context-Aware Navigation System. Efficient Bandwidth Allocation, Use of Cloudlet in Mobile Cloud Computing, Cross-Cloud communication, Elastic Application Model, Resource Management	**8**

Text Books:

1. Mobile Cloud Computing: Architectures, Algorithms and Applications, by Debashis De , CRC press

2. Mobile Clouds: Exploiting Distributed resources in wireless mobile and social networks,by Frank Fitzek, Marcos D. Katz Wiley

3. Mobile Cloud computing: Principles and paradigms by Khanna, Sarishma

References:

1. Architecting the cloud by Kavis Wiley publication

2. Advances in Mobile cloud computing systems by F. Richard Yu. , Victor Leung, CRC press

3. Mobile computing with Cloud byIshwaryaChandrasekaran Springer

4. Mobile cloud computing: An Introduction by Jyoti Grover and Gaurav KLheterpal , IGI GLobal

List of Experiments: based on Laboratory Practical's/ Case studies

1. Offloading the applications from mobile to cloud

2. Traffic analyses and measurements

3. Application in Social Cloud

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO1014	**IT Strategy**	**04**

Course Objectives:

1. To appraise the operational, competitive and strategic value of information technology, and how its management and governance contributes to the realization of that value
2. To introduce key concepts to develop a broad and critical understanding of IT strategy development, implementation and value issues (such as IT and business alignment, IT capability, strategic relevance of emerging IT, change management) and provide a conceptually and theoretically sound explanation about these issues.
3. To introduce methods for evaluating emerging technologies and forecasting the rate of technological advance.
4. To focus on procedures for quantifying various types of risk in IT investments, identifying tangible and intangible costs and benefits.

Course Outcomes: Learner will be able to:

1. To develop variety of ways were IT can enable and create business opportunities.
2. Design and develop the business strategy map and the IT strategy with end-to-end strategic business-IT alignment enabling management, coordination and monitoring the firm's strategy to ensure desired business outcomes.
3. Use data driven approaches to evaluate extant and predicting future directions and likely developments in technologies, identify solutions based on industry and technology trends that improve IT and business alignment, and business performance.
4. Analyze and evaluate the IT capabilities, develop ways to mitigate risky IT initiatives

Prerequisite: Fundamental of Computer Technology.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Basic of IT infrastructure and Internet Technology.	**3**
I	Business Models, Competitive Strategy and Organization Mission	How businesses are modeled, and how they compete. The mission of businesses and other organizations, and the relationship between an organization's mission and its strategy. Competitive Domains, Competitive Consequences of Technological Change – Creation of New Products, Changes in the Value Chain, Changes in the Value Constellation, Competitive Rivalry. Technological Characteristics of Competitive Domains – Technological Opportunity, Resource Requirements, Collateral Assets, Institutional Milieu, Speed. Dynamics of Change in the Competitive Domain – Technology Emergence Phase, Incremental Change Phase. Framework for Analysis of Technology Emergence, Influence of Environmental trends on competition. Technology as critical to Business Outcomes – Technology Strategy and Technology Leadership	**9**
II	Technology Intelligence	Signals of New Technology, What is Technology Intelligence, Importance of Technology Intelligence, Levels of Technology Intelligence, External versus Internal Technology Intelligence. Mapping the Technology Environment – Steps in Mapping, Mapping the Macro level	**8**

		and Industry Level Environment. Mechanisms for Data Collection – Challenges, Organizational Arrangements and Key Principles for Data Collection	
III	Business Strategy and Technology Strategy	Business Strategy , Strategic Analysis and Decision Making using Product Evaluation Matrix, Market-Growth-Market-Share Analysis Matrix, X-Y Coordinating Method, M-by-N Matrix, SWOT Matrix, Formulation of Technology Strategy, Core Competencies, Exploitation of Core Competencies, Integration, Linking Technology & Business Strategies, Creating the Product-Technology-Business Connection. Technology's Interface with – Market, Customers and Suppliers. Customer Supplier and Product-User relationships.	**8**
IV	IT and the Digital Organization	The functionality of the digital organization, and the role that IT plays in supporting it. Competitive and operational perspectives on IT, including analysis of both benefits and risk.	**4**
V	Alignment of IT with Business strategy	IT and Michael Porter's Competitive Forces Framework IT and Value Chain Framework IT and Business Process Reengineering; Virtual Organizations IT and Competitive Advantage	**8**
VI	Enterprise architecture & strategic planning	IT Strategy Initiation, IT management best practices Control Objectives for Information and related Technology (COBIT) framework , IT Strategy Planning, Outsourcing, Off shoring & IT Subsidy, Critical success factors of IT strategy	**8**

Text Books:

1. IT strategy issues and practices, James D. McKeen and Heather A. Smith, Pearson

2. IT strategy and man agent, S.S. Dubey, PHI

3. Management of Technology – The Key to Competitiveness and Wealth Technology & Business Strategy – An Introduction, Edited by Prashanta Kumar Banerjea, ICFAI books

References:

1. Strategic Management of Technology & Innovation, Robert A Burgelman, Modesto A Maidique, Steven C Wheelwright, MGH International Edition.

2. Managing Technology and Innovation for Competitive Advantage, V K Narayanan, Pearson Education, and 2009 Edition.

3. Technology Management – Text and International Cases, Norma Harrison and Danny Samson, MGH

List of Experiments: based on Laboratory Practical's/ Case studies

1. Prahalad, C. K., & Krishnan, M. S. (2002). The dynamic synchronization of strategy and information technology. *MIT Sloan management review*, *43*(4), 24. (Develop a set of questions based on this article for teaching)

2. IT-LED BUSINESS TRANSFORMATION AT RELIANCE ENERGY Deepa Mani; Geetika Shah; Revati Nehru available from Harvard Business Publishing

3. ENABLING THE STRATEGY-FOCUSED IT ORGANIZATION Robert S. Gold available from Harvard Business Publishing

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO1015	**Knowledge Management**	**04**

Course Objectives:

1 Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits, and guiding principles on which to build greater understanding of knowledge management

2 Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.

3 Increase information and understanding about knowledge transfer using low- and high technology strategies

4 Explore the future of knowledge management and its influence on our jobs, communities, and society

Course Outcomes: After completion of the course the learner will be able to

1) Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.
2) Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems
3) Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.
4) Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy Ponder KM's current and future impact on individuals, organizations and society at large

Prerequisite: An introductory course in IT/ IS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge -Subjective & Objective views of knowledge, procedural Vs. Declarative, tacit Vs. explicit, general Vs. specific.	**3**
I	Introduction to Knowledge Management	What is Knowledge? Types of expertise – associational, motor skill,¬ theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role Relevance of KM in today's dynamic & complex environment Future of Knowledge Management	**5**
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation. Knowledge Architecture.	**8**
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory	**8**

		Grid- Concept Mapping –Blackboarding, Nominal Group Technique, Delphi method,	
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer's Skill Sets – System Testing and Deployment – Knowledge Testing –Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation.	**8**
V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers.	**8**
VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures Identification of appropriate KM solutions, Ethical Legal and Managerial Issues	**8**

Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies . Prentice Hall. ISBN: 0-13-109931-0.

2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13-034820-1

3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).

4. Shelda Debowski, Knowledge Management, Wiley India Edition.

References:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.

2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.

3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.

4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.

List of Experiments : based on Laboratory Practical's/ Case studies

1. Daimler Chrysler Knowledge Management strategy, Michael G Rukstad and Peter Coughlan , Harvard Publishing

2. Andreu, R., Grau, A., Lara, E., & Sieber, S. (2003). Knowledge Management at Siemens Spain, PRISM case# 9.5. 3, University of Navarra, IESE, Spain. *Distributed by The European Case Clearing house, England and USA*.

3. 5 Big Companies That Got Knowledge Management Right – John Mc Cormick

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Course Code	Course Name	Credits
ILO1011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05

06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE).
2. To list the guidelines for designing experiments.
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001

3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill.
7. Madhav S Phadake, "Quality Engineering using Robust Design," Prentice Hall.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05

05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.

7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 **Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.**	03
02	**Natural Disaster and Manmade disasters:** **2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion** **2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.**	09
03	**Disaster Management, Policy and Administration** **3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.** **3.2 Policy and administration:** **Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.**	06
04	**Institutional Framework for Disaster Management in India:** **4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.** **4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.**	06
05	**Financing Relief Measures:** **5.1 Ways to raise finance for relief expenditure, role of government agencies and**	09

	NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. **5.2 International relief aid agencies and their role in extreme events.**	
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:**	04

	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
MEITC201	**Security & Risk Management**	**04**

Course Objective:

1. To gain knowledge about information security and Risk Management
2. To be familiar with Risk assessment methodology and risk mitigation approaches
3. To gain an overview about security management concepts and configuration management
4. To understand IT audit and its activities

Course Outcomes:

After completion of the course the gain knowledge of the following

1. Able to explain the knowledge about information security and Risk Management
2. Able to analysis Risk assessment methodology and risk mitigation approaches
3. Able to explain security management concepts and configuration management
4. Able to explain IT audit and its activities

Pre-requisite : Computer Networks.

DETAILED SYLLABUS:

Module	Detailed content	Hours
Prerequisite	**Overview of Information Security Management** The big picture, Learning from experience, Weaknesses in Information Security. The extent of crime in cyberspace, Cyberspace crimoid syndrome, Policies and technologies, A new frame work for Information security.	3
I	**Introduction to Information Security** Basic information security model, Need for security, Common vulnerabilities, threats and attacks, Asset Identification and Characterization – Asset types, Asset characterization, IT Asset life cycle and asset identification, Threat models, Encryption controls.	5
II	**Information Security Risk Assessment Basics** What is Risk? Information Security Assessment Overview, Risk Assessment Framework: NIST 800-39, OCTAVE, ISO 27000 series, Data Collection and Analysis, Asset scoping, Preparation of Threat and Vulnerability Catalogs, System Risk Computation, Impact Analysis Scheme, Final Risk Score.	8
III	**Risk Assessment Methodology** Introduction to Risk assessment, Defense-in Depth Approach, Qualitative and Quantitative risk assessment approaches, Problems with Quantitative approach, Risk Control Strategies, System Risk Analysis, Risk Prioritization, System Specific Risk Treatment.	8
IV	**Performing the Assessment** Vulnerability scan and Exploitation: Internet Host and network enumeration, IP network scanning, Assessing Remote Information Services, Assessing Web	10

	Servers, Assessing Web Applications, Assessing Remote Maintenance Services, Assessing Database Services, Assessing Windows Networking Services, Assessing Email Services. Scanning and Analysis tools and their working principle. Final Report Preparation and Post Assessment Activities.	
V	**Security Management Concepts and Principles** Measuring ROI on security, security patch management, Purpose of Information Security management, and The building blocks of information security. Overview of SSE CMM, SSE CMM relationship to other initiatives, capability levels, Security Engineering process overview. Configuration management: Role of CM in Security of an organization. CM framework, Three disciplines of CM:Business Process Infrastructure (Chain of Command, CCB), Operations and Services (Operational Group) ,End Products (technical group) with respect to security.	8
VI	**Planning for Security:** Information Security Planning and Governance, Information Security Policy Standards, EISP, ISSP, SysSP, Policy management. **Security Audit Process:** Pre-planning audit, Audit Risk Assessment, Performing Audit, Internal Controls, Audit Evidence, Audit Testing, Audit Finding, Follow-up activities.	6

References

1. Manish Agarwal, Alex Campoe and Eric Pierce, "Information Security and IT Risk Management" Wiley 2016.
2. Principles of Information Security, Michael E Whitman, Herbert J. Mattod, 4th Edition, Cengage Learning.
3. Mark Talabis, "Information Security Risk Assessment Toolkit: Practical Assessments through Data Collection and Data Analysis", Kindle Edition.ISBN:978-1-59749-735-0.
4. David L.Cannon, "CISA Certified Information Systems Auditor Study Guide", SYBEX Publication. ISBN: 978-0-470-23152-4.
5. Network Security Assessment, Chris McNab, O'reilly
6. Inside Security Assessment, Micheal Gregg, Pearson
7. The Security Risk Assessment Handbook: Douglas LanDoll, Auerbach Publication
8. Micki Krause, Harold F.Tripton, "*Information Security Management Handbook*", Auerbach Publications, 2012.

List of Experiments:

1. Working with scanning enumeration tool
2. Understanding practical aspect operating system security, Linux and Windows
3. Working with open source security information management for security audit (OSSIM)

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITC202	**High Performance Computing**	**04**

Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using Parallel programming paradigms.
3. To learn CUDA Programming Language and tools.
4. Performance comparison between CUDA, MPI and OpenMP.

Course Outcomes: Learner will be able to:

1. Determine the complexity of a given parallel algorithm
2. Identify design Issues and limitations in Parallel Computing.
3. Design algorithms suited for Multicore processor and GPU systems using CUDA, MPI, OpenMP.
4. Analyze and optimize performance parameters.

Pre-requisite: Mathematics, Data structures.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Pre-requisite	High performance computing through a number of applications in science and engineering, including problems in linear algebra, partial differential equations (e.g. computational fluid dynamics), molecular dynamics, and agent based modelling. Study of various numerical methods used in engineering practice and how these applied to solving computational problems and hence programmed for execution on a supercomputer.	3
I	Parallel Processing Approaches	**Introduction to Parallel Processing:** Levels of Parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation etc.), Loosely coupled and Tightly coupled **HPC Platforms:** CUDA, Message-passing Interface (MPI), Shared-memory thread-based OpenMP programs, hybrid (MPI/OpenMP) programs, Grid Computing, Cloud Computing , Multi-Core Processors, accelerators, GPGPUs	6
II	Design Issues and limitations in Parallel Computing	Parallel Architecture, (Interconnection network, processor Array, Multiprocessor) Designing Parallel algorithms (Partitioning, Communication, Mapping, Matrix input/output) **Issues:** Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures **Limitations:** Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	8

III	Programming using CUDA	CUDA: a) Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture) b) Memory hierarchy and transaction specific memory design c) Thread Organization, The Implementation of the Cilk-5 Multithreaded Language, MapReduce: simplified data processing on large clusters, StreamIt: A Language for Streaming Applications, PetaBricks: A Language and Compiler for Algorithmic Choice, Pregel: a system for large-scale graph processing, PowerGraph: Distributed Graph-Parallel Computation on Natural Graphs, GraphChi: Large-Scale Graph Computation on Just a PC, The Tao of Parallelism in Algorithms	12
IV	Programming using MPI and Open MP	MPI: Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs; OpenMP: Threading, Building blocks, Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing.	8
V	Performance Measures	Performance measures: Speedup, efficiency and scalability. Abstract performance metrics (work, critical paths), Amdahl`s Law, Gustavson's law, weak vs. strong scaling, performance bottlenecks, data races and determinism, data race avoidance (immutability, futures, accumulators, dataflow), deadlock avoidance, abstract vs. real performance (granularity, scalability)	07
VI	HPC enabled Advanced Technologies	(a) Petascale Computing (b) Optics in Parallel Computing (c) Quantum Computers (d) Recent developments in Nanotechnology and its impact on HPC	04

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.

2. Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, 1993.

3. Edward Kandrot and Jason Sanders, CUDA By Example – An Introduction to General Purpose GPU Programming, Addison-Wesley Professional ©, 2010.

4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, "Heterogeneous Computing with OpenCL", McGraw-Hill, New York, 2011.

5. CUDA C PROGRAMMING GUIDE, September 2015.

Reference Books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.

2. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill International Editions, Computer Science Series, 2004.

3. Kai Hwang, “Scalable Parallel Computing: technology, architecture, programming”, McGraw Hill 1998

4. Laurence T. Yang, MinyiGuo, “High- Performance Computing: Paradigm and Infrastructure ” Wiley

List of Experiments:

1. OpenMP implementation
   workload partitioning based on 1, 2, 4 and 8 core configurations
2. MPI implementation
   workload partitioning based on 1, 2, 4, 8, 16, 32 node configuratations.
3. Performance comparison between CUDA, MPI and OpenMP implementations
   i. Execution time
   ii. Programming effort
      1. Quantify the speedup you are getting compared to a single processor (single thread) implementation with respect to the amount of programming and design effort you invested
   iii. Limitations of your implementation from both hardware and software perspectives
      1. how does the target architecture impact your paralleization strategy
      2. how does the programming environment effect the speedup you are achieving

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITC203	**Advanced Web Technology**	**04**

Course Objectives:

1 Get familiar with Web Technologies.

2 Gaining a good grasp over Web 2.0 technologies in order to develop responsive web applications

3 Exploring the advantages of emerging web technologies and what environment they are being used in

4 Exploring Web 3.0 and Semantic Web standards

Course Outcomes: Student will be able:

1) To design a responsive web site using HTML5 and CSS.

2) To design RIA using proper choice of Framework

3) To recognize and evaluate website organizational structure and design elements

4) Explain emerging web 3.0 standards

Prerequisite: web programming, C language

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	**Introduction to web technologies**: Web system architecture-1,2,3 and n tier architecture, URL, domain name system, overview of HTTP and FTP, Cross browser compatibility issues, W3C Validators **Web Site Design Issues**: Planning a Web Site –Objective and Goals, Audience, Organizing contents. **Publishing of Web Site**. **Function of Web Server** **Basic HTML**: Formatting and fonts, Anchors, images, lists, tables, frames and forms. XML basics.	03
I	Web Technology Basics & HTML 5.0	**HTML 5:** Fundamental Syntax and Semantics, Progressive Markup and Techniques, Forms, Native Audio and Video, Micro data and Custom data, Accessibility, Geo-location, Canvas.	06
II	Responsive web design with HTML5 and CSS3	**Introduction to CSS**: Evolution of CSS, Syntax of CSS, Exploring CSS Selectors, Inserting CSS in an HTML Document, Defining Inheritance in CSS	02
		CSS3 and Responsive Web Design. **CSS3:** Selectors, Typography and color Modes Stunning Aesthetics with CSS3, CSS3 Transitions, Transformations and Animations, Conquer Forms HTML5 and CSS3	06
III	Web Services	**Web Services:** Web services, Evolution and differences with Distributed computing, XML, WSDL, SOAP, UDDI, Transactions, Business Process Execution Language for Web Services, WS-Security and the Web services security specifications, WS-Reliable Messaging, WS-Policy, WS-	07

		Attachments. REST-ful web services, Resource Oriented Architecture, Comparison of REST, SOA, SOAP.	
IV	Rich Internet Application (RIA)	**Introduction to Ajax:** Ajax Design Basics, JavaScript, Blogs, Wikis, RSS feeds **Working with JavaScript Object Notation (JSON):** Create Data in JSON Format, JSON parser, Implement JSON on the Server Side, Implementing Security and Accessibility in AJAX **Applications:** Secure AJAX Applications, Accessible Rich Internet Applications, **Developing RIA using AJAX techniques:** CSS, HTML, DOM, XMLHTTPRequest, JavaScript, PHP, AJAX as REST Client **Open Source Frameworks and CMS for RIA:** Django, Drupal, Joomla introduction and comparison.	08
V	Web Analytics 2.0	Introduction to Web Analytics 2.0 1: State of the Analytics Union, State of the Industry, Rethinking Web Analytics: Meet Web Analytics 2.0, Optimal Strategy for Choosing Your Web Analytics Soul Mate. The Awesome World of Clickstream Analysis: Metrics. The Key to Glory: Measuring Success. Failing Faster: Unleashing the Power of Testing and Experimentation.	08
VI	Web 3.0 and Semantic Web	**Web 3.0 and Semantic Web**: Challenges, Components, Semantic Web Stack: RDF, RDF Schema (RDFS), Simple Knowledge Organization System (SKOS), SPARQL as RDF query language, N-Triples as a format for storing and transmitting data, Turtle (Terse RDF Triple Language), Web Ontology Language (OWL) a family of knowledge representation languages, Rule Interchange Format (RIF), a framework of web rule language dialects supporting rule interchange on the Web.	08

Text Books:

1. HTML 5 Black Book: Kogent Learning solutions
2. Tim O'Reilly, What is Web 2.0? : Design Patterns and Business Models for the Next Generation of Software, O'REILLY
3. John Davies, Rudi Studer, and Paul Warren John , "Semantic Web Technologies: Trends and Research in Ontology-based Systems", Wiley & Son'
4. Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity
Avinash Kaushik, ISBN: 978-0-470-52939-3, wiley publication.

References:

1. Grigoris Antoniou and Frank van Harmelen,. A Semantic Web Primer: MIT Press,2004, ISBN 0-262-01210-3
2. Deane Brker, Web Content Management: Systems, Features, and Best Practices, O'Reilly & Associates incorporated, 2016
3. John Domingue, Dieter Fensel, Handbook of Semantic Web Technologies, Springer Reference
4. Liyang Yu, a Developer's Guide to the Semantic Web, Second Edition, Springer
5. An introduction to RDF and Jena RDF API, www.jena.apache.org/tutorials/rdf_api.html.

List of Experiments: based on Laboratory Practical's/ Case studies

1. Design a website with features like login for users and several gadgets, it should atleast have a twitter box, a video, a calendar with events, event announcements and information with a registration form.

2. A mini project based on REST API and web analytics 2.0

3. Apache Jena based RDF and SPRQL based Tutorials

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO2021	**E-Business and Social Network Analysis**	**04**

Course Objectives:

1) To understand e-Business as a significant business segment for the future.

2) To get an overview of technological and strategic aspects of e-Business.

3) To know basics of Social Network Analysis.

4) To visualize, summarize and analyze the effect of Social Networks on e-Business.

Course Outcomes: At the end of the course the students will be able to

1) Develop a complete e-business strategy.
2) Develop and implement complete e-commerce site.
3) Visualize/Analyze real world Social Networks.
4) Analyze the impact of Social Networks on e-Business.

Prerequisite: E-Commerce and E-Business

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**
	Prerequisite	Defining e-Business, Framework for understanding e-Business.	**3**
I	Introduction to e-Business	Fundamental Models of e-Business, Preparing e-Business Plan, and Environmental forces affecting planning & practice, Trends in e-Business.	**5**
II	e-Business and e-Marketing Strategies	Strategic planning process, SCM, CRM and ERP, Marketing Strategies and Revenue Models.	**8**
III	e-Payment Systems and Security	Concept of Money, Electronic Payment Systems (EPS), Types of EPS, Smart Card and EPS, Electronic Fund Transfer, Security issues and measures like digital certificate, digital signature, encryption, SSL and SET protocols.	**8**
IV	Introduction to Social Network Analysis	Concepts: nodes, edges, adjacency matrix, one and two node networks, node degree, Introduction to social network analysis, Network examples, Graph theory basics, Statistical network properties, Degree Distribution, Clustering Coefficients, Frequent patterns, Network motifs, Cliques and k-cores, Node centralities and ranking on Network nodes and edges, Network diameter and average path length.	**8**
V	Network Communities and Visualization	Network Structure, Network Communities, Graph partitioning and cut metrics, Information and Influence of propagation on networks, Network visualization and Graph layouts, Social diffusion.	**8**
VI	SNA in real world	Applications/Case Studies based on the impact of SNA on e-	**8**

		Business, Impact of SNA on consumer behavior.	

Text Books:

1. E-Business: Business, Technology and Society: Kenneth C. Laudon (Author), Carol Traver (Author)

2. E-Business and E-Commerce management Strategy, Implementation and Practice: Dave Chaffey

3. John Scott, "Social network Analysis" Third edition, SAGE Publications

References:

1. E-Commerce : Ninth edition : Gary Schneider, Cengage
2. Christina Prell, "Social Network Analysis: History, Theory and Methodology", SAGE 2011
3. Stephen P Bergatti, Martin G Everett, Jaffery C Johnson, "Analyzing Social Networks", SAGE 2013.
4. Stanley Wasserman, Katherine Faust, "Social Network Analysis: Methods and Applications"

List of Experiments: based on Laboratory Practical's/ Case studies

1. Develop a Business Plan – Identifying the business model, Develop strategic plan, Design Screen Shots, Show few activities (related to CRM, SCM, Marketing, security etc.), organizational structure, s/w & h/w requirements.

2. Create random Networks, Calculate component distribution, average shortest path and evaluate impact of structure on ability of information to diffuse, calculate and interpret node centrality for real world networks.

3. Read recent research based on these services and learn how SNA concepts are applied on e-Business.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO2022	**AI and Machine Learning**	**04**

Course Objectives:

1 To learn the basic concepts and techniques of AI and machine learning
2. To explore the various mechanism of Knowledge and Reasoning used for building expert system.
3. To become familiar with supervised and unsupervised learning models
4. To design and develop AI and machine learning solution using modern tools.

Course Outcomes: Students will able to:

1. Explain the fundamentals of AI and machine learning.
2. Identify an appropriate AI problem solving method and knowledge representation technique.
3. Identify appropriate machine learning models for problem solving.
4. Design and develop the AI applications in real world scenario.

Prerequisite: Probability Theory and Statistics, PROLOG, R Programming

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**
	Prerequisite	Basics of AI, Need for AI Basics of ML, Types, need for ML	3
I	Introduction to AI	Definition, Problem, State space representation. Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Applications of AI, Current trends in AI, Intelligent Agents: Anatomy, structure, Types	6
II	Problem solving	Solving problem by Searching: Problem Solving Agent, Formulating Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search	8
III	Knowledge and Reasoning	Knowledge based Agents, The Wumpus World, and Propositional logic. First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution,	8
IV	Concepts of Machine learning	Supervised, unsupervised, semi-supervised, Rote learning, Reinforcement learning, Issues, steps and applications, Designing a learning System. Case study: hand written digit recognition, stock price prediction	3
V	Learning Models	Decision tree learning. Probabilistic Models: Multivariate Bernoulli Naive Bayes	12

		Classifier, Linear and Logistic Regression. Deterministic Models: Support Vector Machine. Hidden Markov Model: Process, Model, Problems of HMM, Viterbi algorithm, Baum- welch algorithm. Reinforcement Learning: Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	
VI	Artificial Neural Network	Introduction, neural network representation, Problems for neural network learning, perceptron, multilayer network & Back propagation Algorithm. Deep learning: Definition, relationship between AI, ML, and Deep Learning, Trends in Deep Learning.	8

Text Books:

1. Artificial Intelligence and Machine Learning By Vinod Chandra S.S., Anand Hareendran S

2. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach "Second Edition" Pearson Education

3. Tom M. Mitchell. "Machine Learning" McGraw-Hill, 1997.
4. Ethem Alpaydin "Introduction to machine learning" 2nd ed. The MIT Press, 2010

References:

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight "Artificial Intelligence "Third Edition
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Han Kamber, "Data Mining Concepts and Techniques", Morgann Kaufmann Publishers.

5. "Machine learning with R" by Brett Lantz

List of Experiments : based on Laboratory Practical's**/** Case studies

1. Logic programming with **Prolog**

2. Machine Learning with **R**

3. Training and testing using Artificial Neural Network

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO2023	**Ethical Hacking and Digital Forensic**	**04**

Course Objectives:

1 Lerner should learn various aspects of network security
2 Lerner should learn different technologies for website security
3 Lerner should learn various aspects of mobile security
4 Lerner should learn various forensic methods for identification of fraud.

Course Outcomes:

1) Explain Knowledge about various aspects of network security.
2) Design and Develop of secure website.
3) Identify various security aspects with respect to mobile technology.
4) Explain solutions for various case studies with the help of forensic techniques.

Prerequisite: Computer Network fundamentals for communication, Static and Dynamic website development, Basics of mobile communications

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	**Introduction:** Ethical Hacking terminology, Five stages of hacking, Vulnerability Research, Legal implication of hacking, Impact of hacking.	**3**
I	Overview of Computer Forensics Technology	Introduction to Computer Forensics, Use of Forensics in Law Enforcement, Employment Proceedings, Computer Forensics services. Types of Computer, Forensics Technology- Military, law, Spyware and Adware, Biometrics security systems.	**5**
II	Foot Printing & Social Engineering	Information gathering Methodologies, Competitive Intelligence, DNS Enumerations, Social Engineering attacks. **Types of Computer Forensics systems:** Internet security, IDS, Firewall, Public key, Net privacy systems, Vendor and computer Forensics services.	**6**
III	Incident and Incident Response and Storage	Introduction to Incident, Incident Response Methodology, Steps, Activities in Initial Response Phase after detection of an incident. **Initial Response and Forensic Duplication:** Initial Response & Volatile Data Collection from Windows system, Initial Response & Volatile Data Collection from Unix system, **Forensic Duplication:** Forensic duplication as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive. **Storage and Evidence Handling:** File Systems: FAT, NTFS, Forensic Analysis of File systems, Storage Fundamentals: Storage Layer, Hard Drives. Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure. **Digital Forensics:** Introduction – Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential, Device handling: seizure issues, device identification, networked devices and contamination.	**10**

IV	Network Forensics	Collecting Network Based Evidence, Investigating Routers, Network protocols, Email Tracing, Internet Fraud.	**8**
V	Mobile Phone Forensics	Crime and mobile phones, evidences, forensic procedures, files present in SIM card, device data, external memory dump, evidences in memory card, operators systems. Android Forensics: Procedures for handling an android device, imaging android USB mass storage devices, logical and physical techniques.	**8**
VI	Hacking	**Scanning & Enumeration:** Port Scanning, Network Scanning, Vulnerability Scanning, NMAP Scanning tool, OS Fingerprinting, Enumeration. **System Hacking:** Password cracking techniques, Key loggers, Escalating privileges, Hiding Files, Steganography Technologies, Countermeasures. **Sniffers & SQL Injection:** Active and passive sniffing, ARP Poisoning, Session Hijacking, DNS Spoofing, Conduct SQL Injection attack, Countermeasures. **Systems Investigation and Ethical Issues:** Data Analysis Techniques, Investigating Live systems (Windows & Unix), Investigating Hacker Tools, Ethical Issues, Cybercrime. Reconnaissance, Scanning Host discovery, Network devices discovery, service discovery, Backdoors and Trojan horses, Buffer Overflows, Covering Tracks: Networks and systems, Denial of service Attacks, Exploiting system using Netcat, IP address Spoofing, Network Sniffing, Password Attacks, rootkits, Session Hijacking and Defenses.	**8**

Text Books:

1. Kevin Mandia, chirs Proise, “Incident Response and Computer Forensic”

2. Gregory Kipper, “” Wireless Crime and Forensic Investigation”, Auerbach publication, 2007

3.Peter Stepheson,”Investigating Computer Crime: A handbook for corporate investigation”, Sept 1999

References:

1.Skoudis E. Perlman R. counter hack: A step by step Guide to Computer Attacks and effective Defense, Prentice Hall Professional technical Reference, 2001.

2. John R Vacca “Computer Forensic ” Second Edition

3.Hacker Techniques, Exploits and incident Handling http://www.sans.org

List of Experiments : based on Laboratory Practical’s**/** Case studies

1. Develop secure web site.

2. Sniffers and SQL Injection.

3. Digital Forensics.

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO2024	**Internet of Things**	**04**

Course Objectives: The course objectives are to:

- Provide an overview of concepts, main trends and challenges of Internet of Things.
- Develop the ability to use Internet of Things related software and hardware technologies.
- Provide the knowledge of data management business processes and analytics of IoT.
- Develop skills to relate the IoT technologies for practical IoT applications such as smart objects.

Course Outcomes: Learner will able to:

- Explain and interpret the Internet of Things concepts and challenges.
- Experiment with the software and hardware IoT Technologies.
- Identify data management and business processes and analytics of IoT
- Design and develop small IoT applications to create smart objects

Perquisite: Web Programming, Microcontroller

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**
	Perquisite	Web Programming Concepts, Tools, Framework.	3
I	Introduction to Internet of Things	Definition of Internet of Things (IoT), IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Real world scenarios, Different Areas, Examples Trends in the Adaption of the IoT (Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects).	5
II	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Actuators and Interfacing.	8
III	IoT Protocol & Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others. IoT Protocols - M2M, BacNet, ModBus, Bluetooth, Wifi, ZigBee.	8
IV	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT. Networking and the Internet - IP Addressing, Protocols - MQTT, CoAP, REST Transferring data.	6
V	Data Analytics for IoT	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis,	10

		Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study - Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator.	
VI	Application and Use Cases	Concrete Applications and Use – Cases of Web Enabled Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. Cloud of Things and Big Data. Business Cases and Issues - Agriculture, Music Therapy, Smart Home, Smart Grid Network, Wearable, Healthcare.	8

Text Books:

1 The Internet of Things (MIT Press) by Samuel Greengard.

2 The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).

3 Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

1 The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.

2 IoT –From Research and Innovation to Market development (River Publication) by Ovidiu Vermesan and Peter Friess.

3 Building Internet of Things with Arduino by Charalampos Doukas.

List of Experiments :

1) Implement A Heterogeneous, Hierarchical Wireless Sensor Network using Cooja/ MSPSim Simulator also add routing protocol, broadcasting message in WSN.
2) Create a smart city and IoT WSN using CupCARBON U-ONE 2.8.5 simulator and senscript.
3) Building machine to machine (M2M) applications such as remote monitoring/Vehicle Tracking, fleet management or smart grid using M2MLabs open source application framework.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MEITDLO2025	**Advanced Software Quality Assurance**	**04**

Course Objectives: Objectives of this course include:

1. Examining various methods and approaches used to improve the quality of a product or service.
2. Exploring the principles and techniques used to evaluate both functional and non-functional requirements
3. Distinguish between the various activities of quality assurance, quality planning and quality control.
4. Understand the importance of standards in the quality management process and their impact on the final product.

Course Outcomes: On successful completion of the course students will be able to

1. Explain the established concepts, the fundamental test process, test management principles, test strategies/approaches, risks and principles to support test objectives.
2. Analyze and prioritize both functional and non-functional specifications, such as performance efficiency and usability, design tests using established techniques for functional tests at all test levels for systems of small to medium complexity
3. Interpret and execute tests according to agreed test specifications and analyze and report on the results of tests independently
4. Implement testing tools for various testing activities

Prerequisite: Software engineering.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Software engineering (or) Experience in software development. Any one programming language and IDE. Knowledge of testing tools is advantageous.	**3**
I	Fundamentals of software Testing Process: defects, hypotheses, and tests	Basic Definitions, Software Testing Principles , The Role of Process in Software Quality, Testing as a Process , Overview of the Testing Maturity Model , The Tester's Role in a Software Development Organization Origins of Defects, Defect Classes, the Defect Repository, and Test Design. Requirements and Specification Defects. Design Defects. Coding Defects. Testing Defects, Developer/Tester Support for Developing a Defect Repository.	**4**

II	Strategies and methods for test case design	Test Case Design Strategies - Using the Black Box Approach to Test Case Design, Random Testing, Equivalence Class Partitioning, Boundary Value Analysis , Cause-and-Effect Graphing, State Transition Testing, Error Guessing, Black Box Testing and Commercial Off-the-Shelf Components (COTS). Using the White Box Approach to Test Design, Test Adequacy Criteria, Coverage and Control Flow Graphs, Covering Code Logic, Paths: Their Role in White Box–Based Test Design, Data Flow and White Box Test Design, Loop Testing, Mutation Testing.	**11**
III	Levels of testing	Levels of Testing and Software Development Paradigms , Unit Test: Functions, Procedures, Classes, and Methods as Units , Unit Test Planning , Designing the Unit Tests , The Class as a Testable Unit, The Test Harness. Integration Test: Integration Strategies for Procedures and Functions, Integration Strategies for Classes, Designing Integration Tests, Integration Test Planning ,System Test: The Different Types, Functional Testing, Performance Testing , Stress Testing, Configuration Testing, Security Testing, Recovery Testing , Regression Testing , Alpha, Beta, and Acceptance Tests .Role of Use Cases.	**10**
IV	Reviews as a testing activity	Types of Reviews – Inspections, Walkthroughs, Developing a Review Program, The Need for Review Policies, Components of Review Plans, Review Goals, Preconditions and Items to be Reviewed, Review Procedures, Review Checklists. Reporting Review Results, Review, Rework, and Follow-Up , Review Metrics , The Self-Check or Personal Review, software Quality Evaluation	**4**
V	Evaluating software quality	Quality Costs, Quality Control, Statistical Testing, Software Reliability, Measurements for Software Reliability, Applying Reliability Models, Confidence Levels and Quality Control, Usability Testing and Quality Control , Assessment Usability Testing, Validation Usability Testing. Resource Requirements - Usability Tests and Measurements DEFECT ANALYSIS AND PREVENTION -Processes and Defects, Techniques for Defect Analysis Defect Causal Analysis, Making Process Changes, Monitoring Actions and Process Changes, Benefits of a Defect Prevention Program, Defect Prevention and the Three Critical Views	**8**
VI	Test driven development	Overview of testing on agile project**.** What is TDD? TDD and traditional testing, Incremental design, continuous integration, Self-documenting code. TDD and documentation, Scaling TDD via Agile Model-Driven Development (AMDD). Overview of agile TDD tools. Introduction to digital testing	**8**

Text Books:

1. Ilene Burnstein, “Practical software testing”, Springer Professional computing

2. Kshirasagar Naik and Priyadarshi Tripathy (Eds), "Software Testing and Quality Assurance: Theory and Practice", John Wiley, 2008

3. Kent Beck “Test Driven Development”, Addison Wesley.

References:

7. Marnie L. Hutcheson, “Software Testing Fundamentals- Methods and Metrics”, Wiley

8. Boriz Beizer, "Software Testing Techniques", 2nd Edition, DreamTech, 2009.

9. Aditya P. Mathur, "Foundations of Software Testing", Pearson, 2008
10. Mauro Pezze and Michal Young, "Software Testing and Analysis. Process, Principles, and Techniques", John Wiley, 2008
11. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", 2nd Edition, Pearson, 2003

List of Experiments: Use the following tools in laboratories.

CVS: For the software configuration management repository

Bugzilla: For tracking and reporting bugs and change requests

CheckStyle: To verify the source code conformance to the programming language standard

Eclipse: A development environment with a multitude of plug-ins

Logiscope: Product quality measurement

IBM academic program gives many software tools such as the IBM RequisitePro Traceability tool.

DevOps tools: GitHub, Jenkins and Docker.

Laboratory Practical’s/ Case studies –

1. Develop a small application or program additional features into existing software using CVS tool/GitHub

2. Test the software produced using open-source software tools for unit and integration testing. Use IBM RequisitePro/Excel, Bugzilla to update information on defects/changes and inspection,

3. Product quality assessment- Assess source code conformance to customer standards using CheckStyle and software complexity/quality using Logiscope.

4. TDD – Use of DevOps Tools – Jenkins and Docker to build code, create Docker containers, run tests and stage production.

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Course Code	Course Name	Credits
ILO2021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8

06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of	05

	Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2023	Enterpreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi

4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	6

	• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached	**04**

	6.2 Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group

on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business	06

	Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO2029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
MEITL101	**Laboratory I (Core Course Lab)**	**01**

Module	**Detailed content**	**Lab. Sessions**
1	**Two Laboratory Practical's to be conducted for each of the core subjects as suggested in the subject syllabus.**	24

Modality and Assessment:

1. Each Laboratory assignment will be done in a group of two students. The Faculty teaching each core subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.
2. **End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
MEITL102	**Laboratory II –(DLOC & ILOC Lab)**	**01**

Module	**Detailed content**	**Lab. Sessions**
1	**Three Laboratory Practical's to be conducted for each of the DEC & IEC subjects as suggested in the subject syllabus.**	24

Modality and Assessment:

1. Each mini project assignment will be done by individual student. The Faculty teaching elective subject will be required to propose and evaluate the respective mini projects. These will be essentially hands-on practical and not theory / research review types of projects
2. **End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
MEITL201	**Laboratory III-(Core Course Lab)**	**01**

Module	**Detailed content**	**Lab. Sessions**
1	**Two Laboratory Practical's to be conducted for each of the core subjects as suggested in the subject syllabus.**	24

Modality and Assessment:

1. Each Laboratory assignment will be done in a group of two students. The Faculty teaching each core subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.
2. **End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
MEITL202	**Laboratory IV –(DLOC & ILOC Lab)**	**01**

Module	**Detailed content**	**Lab. Sessions**
1	**Three Laboratory Practical's to be conducted for each of the DLOC & ILOC subjects as suggested in the subject syllabus.**	24

Modality and Assessment:

1. Each mini project assignment will be done by individual student. The Faculty teaching elective subject will be required to propose and evaluate the respective mini projects. These will be essentially hands-on practical and not theory / research review types of projects
2. **End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
MEITS301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Information Technology
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures (at least 10 papers from Refereed Journals) and understand the topic and compile the report in standard format and present in front of Panel of Examiners. (pair of Internal and External examiners appointed by the University of Mumbai)
- **Seminar should be assessed based on following points**
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

IMPORTANT NOTE :

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.
4. Students should publish at least one paper based on the seminar work in reputed International / National Conference/Journal (desirably in Referred Journal should be ISI/Scopus/SCI indexing)

Subject Code	Subject Name	Credits
MEITD301/ MEITD401	**Dissertation (I and II)**	**12 + 15**

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
-
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be accessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be accessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai
- Students should publish at least one or two paper based on the work in reputed International / National Conference/Journal (desirably in Referred Journal should be ISI/Scopus/SCI indexing) (desirably in Referred Journal)

AC: 23/7/2020

Item No. 127

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 23/7/2020
Item No. 127

UNIVERSITY OF MUMBAI

Syllabus for Approval

Date

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Computer Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
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Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
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University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Second Year Computer Engineering syllabus effective from the Academic Year 2020-21 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting and challenging.

Computer Engineering is one of the most sought-after courses amongst engineering students hence there is a continuous requirement of revision of syllabus. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
3. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud : Chairman

Prof. Madhumita Chatterjee : Member

Prof. Sunita Patil : Member

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Program Structure for Second Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CSC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
CSC302	Discrete Structures and Graph Theory	3	--	--	3	--	--	3
CSC303	Data Structure	3	--	--	3	--	--	3
CSC304	Digital Logic & Computer Architecture	3	--	--	3	--	--	3
CSC305	Computer Graphics	3	--	--	3	--	--	3
CSL301	Data Structure Lab	--	2	--	--	1	--	1
CSL302	Digital Logic & Computer Architecture Lab	--	2	--	--	1	--	1
CSL303	Computer Graphics Lab	--	2	--	--	1	--	1
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	2+2*	--	--	2	--	2
CSM301	Mini Project – 1 A	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg					
CSC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
CSC302	Discrete Structures and Graph Theory	20	20	20	80	3	--	--	100
CSC303	Data Structure	20	20	20	80	3	--	--	100
CSC304	Digital Logic & Computer Architecture	20	20	20	80	3	--	--	100
CSC305	Computer Graphics	20	20	20	80	3	--	--	100
CSL301	Data Structure Lab	--	--	--	--	--	25	25	50
CSL302	Digital Logic & Computer Architecture Lab	--	--	--	--	--	25	--	25
CSL303	Computer Graphics Lab	--	--	--	--	--	25	25	50
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	--	--	--	--	50	25	75
CSM301	Mini Project – 1 A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

*Should be conducted batch wise and

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

Program Structure for Second Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CSC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
CSC402	Analysis of Algorithm	3	--	--	3	--	--	3
CSC403	Database Management System	3	--	--	3	--	--	3
CSC404	Operating System	3	--	--	3	--	--	3
CSC405	Microprocessor	3	--	--	3	--	--	3
CSL401	Analysis of Algorithm Lab	--	2	--	--	1	--	1
CSL402	Database Management System Lab	--	2	--	--	1	--	1
CSL403	Operating System Lab	--	2	--	--	1	--	1
CSL404	Microprocessor Lab	--	2	--	--	1	--	1
CSL405	Skill Base Lab Course: Python Programming	--	2*+2	--	--	2	--	2
CSM401	Mini Project 1-B	--	4$	--	--	2	--	2
Total		**15**	**16**	**1**	**15**	**7**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
CSC402	Analysis of Algorithm	20	20	20	80	3	--	--	100
CSC403	Database Management System	20	20	20	80	3	--	--	100
CSC404	Operating System	20	20	20	80	3	--	--	100
CSC405	Microprocessor	20	20	20	80	3	--	--	100
CSL401	Analysis of Algorithm Lab	--	--	--	--	--	25	25	50
CSL402	Database Management System Lab	--	--	--	--	--	25	25	50
CSL403	Operating System Lab	--	--	--	--	--	25	25	50
CSL404	Microprocessor Lab	--	--	--	--	--	25	--	25
CSL405	Skill Base Lab Course: Python Programming	--	--	--	--	--	25	--	25
CSM401	Mini Project 1-B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

*Should be conducted batchwise and

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Credits
CSC301	Engineering Mathematics-III	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II	
Course Objectives: The course aims:	
1	To learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2	To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills.
3	To understand the concept of complex variables, C-R equations with applications.
4	To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning, and AI.
5	To understand some advanced topics of probability, random variables with their distributions and expectations.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2	Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3	Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
4	Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
6	Understand the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

Module		Detailed Contents	Hours
1	**Laplace Transform**		7
	1.1	Definition of Laplace transform, Condition of Existence of Laplace transform.	
	1.2	Laplace Transform (L) of standard functions like $e^{at}, sin(at), cos(at), sinh(at), cosh(at)andt^n, n \geq 0$.	
	1.3	Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale, Multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof).	
	1.4	Evaluation of real improper integrals by using Laplace Transformation.	
	1.5	**Self-learning Topics:** Laplace Transform: Periodic functions, Heaviside's Unit Step function, Dirac Delta Function, Special functions (Error and Bessel)	
2	**Inverse Laplace Transform**		7
	2.1	Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace transform using derivatives.	
	2.2	Partial fractions method to find Inverse Laplace transform.	
	2.3	Inverse Laplace transform using Convolution theorem (without proof)	
	2.4	**Self-learning Topics:** Applications to solve initial and boundary value	

		problems involving ordinary differential equations.	
3	**Fourier Series:**		7
	3.1	Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	
	3.2	Fourier series of periodic function with period 2π and $2l$.	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
	3.5	**Self-learning Topics:** Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Fourier Transforms.	
4	**Complex Variables:**		7
	4.1	Function *f(z)*of complex variable, Limit, Continuity and Differentiability of*f(z)*, Analytic function: Necessary and sufficient conditions for *f(z)* to be analytic (without proof).	
	4.2	Cauchy-Riemann equations in Cartesian coordinates (without proof).	
	4.3	Milne-Thomson method: Determine analytic function *f(z)*when real part (u), imaginary part (v) or its combination (u+v / u-v) is given.	
	4.4	Harmonic function, Harmonic conjugate and Orthogonal trajectories.	
	4.5	**Self-learning Topics:** Conformal mapping, Linear and Bilinear mappings, cross ratio, fixed points and standard transformations.	
5	**Statistical Techniques**		6
	5.1	Karl Pearson's coefficient of correlation (r)	
	5.2	Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks)	
	5.3	Lines of regression	
	5.4	Fitting of first- and second-degree curves.	
	5.5	**Self-learning Topics:** Covariance, fitting of exponential curve.	
6	**Probability**		6
	6.1	Definition and basics of probability, conditional probability.	
	6.2	Total Probability theorem and Bayes' theorem.	
	6.3	Discrete and continuous random variable with probability distribution and probability density function.	
	6.4	Expectation, Variance, Moment generating function, Raw and central moments up to 4^{th} order.	
	6.5	**Self-learning Topics:** Skewness and Kurtosis of distribution (data).	

References:	
1	Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
4	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
6	Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series.

Term Work:	
General Instructions:	
1	Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:	
Internal Assessment Test:	
The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test will be for one hour.	
End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Credits
CSC302	Discrete Structures and Graph Theory	3

Pre-requisite: Basic Mathematics	
Course Objectives: The course aims:	
1	Cultivate clear thinking and creative problem solving.
2	Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3	To apply graph theory in solving practical problems.
4	Thoroughly prepare for the mathematical aspects of other Computer Engineering courses
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2	Ability to reason logically.
3	Ability to understand relations, functions, Diagraph and Lattice.
4	Ability to understand and apply concepts of graph theory in solving real world problems.
5	Understand use of groups and codes in Encoding-Decoding
6	Analyze a complex computing problem and apply principles of discrete mathematics to identify solutions

Module	Detailed Contents		Hours
1	**Logic**		6
	1.1	Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Inference Theory of Predicate Calculus, Mathematical Induction.	
2	**Relations and Functions**		**6**
	2.1	Basic concepts of Set Theory	
	2.2	**Relations:** Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes	
	2.3	**Function**s: Definition, Types of functions, Composition of functions, Identity and Inverse function	
3	**Posets and Lattice**		**5**
	3.1	Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattice, Sub lattice	
4	**Counting**		**6**
	4.1	Basic Counting Principle-Sum Rule, Product Rule, Inclusion-Exclusion Principle, Pigeonhole Principle	
	4.2	Recurrence relations, Solving recurrence relations	
5	**Algebraic Structures**		**8**
	5.1	**Algebraic structures with one binary operation:** Semi group, Monoid, Groups, Subgroups, Abelian Group, Cyclic group, Isomorphism	
	5.2	**Algebraic structures with two binary operations:** Ring	
	5.3	**Coding Theory**: Coding, binary information and error detection, decoding and error correction	
6	**Graph Theory**		**8**
		Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex,	

		Applications.	

Textbooks:	
1	Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "Discrete Mathematical Structures", Pearson Education.
2	C. L. Liu "Elements of Discrete Mathematics", second edition 1985, McGraw-Hill Book Company. Reprinted 2000.
3	K. H. Rosen, "Discrete Mathematics and applications", fifth edition 2003, Tata McGraw Hill Publishing Company
References:	
1	Y N Singh, "Discrete Mathematical Structures", Wiley-India.
2	J. L. Mott, A. Kandel, T. P. Baker, "Discrete Mathematics for Computer Scientists and Mathematicians", Second Edition 1986, Prentice Hall of India.
3	J. P. Trembley, R. Manohar "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Publishing Company
4	Seymour Lipschutz, Marc Lars Lipson, "Discrete Mathematics" Schaum"s Outline, McGraw Hill Education.
5	Narsing Deo, "Graph Theory with applications to engineering and computer science", PHI Publications.
6	P. K. Bisht, H. S. Dhami, "Discrete Mathematics", Oxford press.

Assessment:	
Internal Assessment Test:	
The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 40% syllabus is completed. The duration of each test will be for one hour.	
End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Useful Links	
1	https://www.edx.org/learn/discrete-mathematics
2	https://www.coursera.org/specializations/discrete-mathematics
3	https://nptel.ac.in/courses/106/106/106106094/
4	https://swayam.gov.in/nd1_noc19_cs67/preview

Course Code	Course Name	Credit
CSC303	Data Structure	03

Pre-requisite: C Programming	
Course Objectives: The course aims:	
1	To understand the need and significance of Data structures as a computer Professional.
2	To teach concept and implementation of linear and Nonlinear data structures.
3	To analyze various data structures and select the appropriate one to solve a specific real-world problem.
4	To introduce various techniques for representation of the data in the real world.
5	To teach various searching techniques.
Course Outcomes:	
1	Students will be able to implement Linear and Non-Linear data structures.
2	Students will be able to handle various operations like searching, insertion, deletion and traversals on various data structures.
3	Students will be able to explain various data structures, related terminologies and its types.
4	Students will be able to choose appropriate data structure and apply it to solve problems in various domains.
5	Students will be able to analyze and Implement appropriate searching techniques for a given problem.
6	Students will be able to demonstrate the ability to analyze, design, apply and use data structures to solve engineering problems and evaluate their solutions.

Module		Detailed Content	Hours
1		**Introduction to Data Structures**	2
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures.	
2		**Stack and Queues**	8
	2.1	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion.	
	2.2	Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue.	
3		**Linked List**	10
	3.1	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack and Queue using Singly Linked List, Singly Linked List Application-Polynomial Representation and Addition.	
4		**Trees**	11
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree.	
5		**Graphs**	4

	5.1	Introduction, Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS), Graph Application-Topological Sorting.	
6		**Searching Techniques**	4
	6.1	Linear Search, Binary Search, Hashing-Concept, Hash Functions, Collision resolution Techniques	

Textbooks:	
1	Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", Pearson Publication.
2	Reema Thareja, "Data Structures using C", Oxford Press.
3	Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2nd Edition, CENGAGE Learning.
4	Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and Its Applications", McGraw-Hill Higher Education
5	Data Structures Using C, ISRD Group, 2nd Edition, Tata McGraw-Hill.
References:	
1	Prof. P. S. Deshpande, Prof. O. G. Kakde, "C and Data Structures", DreamTech press.
2	E. Balagurusamy, "Data Structure Using C", Tata McGraw-Hill Education India.
3	Rajesh K Shukla, "Data Structures using C and C++", Wiley-India
4	GAV PAI, "Data Structures", Schaum's Outlines.
5	Robert Kruse, C. L. Tondo, Bruce Leung, "Data Structures and Program Design in C", Pearson Edition

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://nptel.ac.in/courses/106/102/106102064/
2	https://www.coursera.org/specializations/data-structures-algorithms
3	https://www.edx.org/course/data-structures-fundamentals
4	https://swayam.gov.in/nd1_noc19_cs67/preview

Course Code	Course Name	Credit
CSC304	Digital Logic & Computer Organization and Architecture	3

Pre-requisite: Knowledge on number systems	
Course Objective:	
1	To have the rough understanding of the basic structure and operation of basic digital circuits and digital computer.
2	To discuss in detail arithmetic operations in digital system.
3	To discuss generation of control signals and different ways of communication with I/O devices.
4	To study the hierarchical memory and principles of advanced computing.
Course Outcome:	
1	To learn different number systems and basic structure of computer system.
2	To demonstrate the arithmetic algorithms.
3	To understand the basic concepts of digital components and processor organization.
4	To understand the generation of control signals of computer.
5	To demonstrate the memory organization.
6	To describe the concepts of parallel processing and different Buses.

Module		Detailed Content	Hours
1		**Computer Fundamentals**	**5**
	1.1	Introduction to Number System and Codes	
	1.2	Number Systems: Binary, Octal, Decimal, Hexadecimal,	
	1.3	Codes: Grey, BCD, Excess-3, ASCII, Boolean Algebra.	
	1.4	Logic Gates: AND, OR, NOT, NAND, NOR, EX-OR	
	1.5	Overview of computer organization and architecture.	
	1.6	Basic Organization of Computer and Block Level functional Units, Von-Neumann Model.	
2		**Data Representation and Arithmetic algorithms**	**8**
	2.1	Binary Arithmetic: Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's and 2's compliment, BCD and Hex Arithmetic Operation.	
	2.2	Booths Multiplication Algorithm, Restoring and Non-restoring Division Algorithm.	
	2.3	IEEE-754 Floating point Representation.	
3		**Processor Organization and Architecture**	**6**
	3.1	Introduction: Half adder, Full adder, MUX, DMUX, Encoder, Decoder(IC level).	
	3.2	Introduction to Flip Flop: SR, JK, D, T (Truth table).	
	3.3	Register Organization, Instruction Formats, Addressing modes, Instruction Cycle, Interpretation and sequencing.	
4		**Control Unit Design**	**6**
	4.1	Hardwired Control Unit: State Table Method, Delay Element Methods.	
	4.2	Microprogrammed Control Unit: Micro Instruction-Format, Sequencing and execution, Micro operations, Examples of microprograms.	
5		**Memory Organization**	**6**
	5.1	Introduction and characteristics of memory, Types of RAM and ROM, Memory Hierarchy, 2-level Memory Characteristic,	
	5.2	Cache Memory: Concept, locality of reference, Design problems based on	

		mapping techniques, Cache coherence and write policies. Interleaved and Associative Memory.	
6		**Principles of Advanced Processor and Buses**	**8**
	6.1	Basic Pipelined Data path and control, data dependencies, data hazards, branch hazards, delayed branch, and branch prediction, Performance measures-CPI, Speedup, Efficiency, throughput, Amdhal's law.	
	6.2	Flynn's Classification, Introduction to multicore architecture.	
	6.3	Introduction to buses: ISA, PCI, USB. Bus Contention and Arbitration.	

Textbooks:	
1	R. P. Jain, "Modern Digital Electronic", McGraw-Hill Publication, 4thEdition.
2	William Stalling, "Computer Organization and Architecture: Designing and Performance", Pearson Publication 10TH Edition.
3	John P Hayes, "Computer Architecture and Organization", McGraw-Hill Publication, 3RD Edition.
4	Dr. M. Usha and T. S. Shrikanth, "Computer system Architecture and Organization", Wiley publication.
References:	
1	Andrew S. Tanenbaum, "Structured Computer Organization", Pearson Publication.
2	B. Govindarajalu, "Computer Architecture and Organization", McGraw-Hill Publication.
3	Malvino, "Digital computer Electronics", McGraw-Hill Publication, 3rdEdition.
4	Smruti Ranjan Sarangi, "Computer Organization and Architecture", McGraw-Hill Publication.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2	https://nptel.ac.in/courses/106/103/106103068/
3	https://www.coursera.org/learn/comparch
4	https://www.edx.org/learn/computer-architecture

Course Code	Course Name	Credits
CSC305	**Computer Graphics**	**3**

Prerequisite: Knowledge of C Programming and Basic Mathematics**.**	
Course Objectives	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasize on implementation aspect of Computer Graphics Algorithms.
3	To prepare the student for advance areas and professional avenues in the field of Computer Graphics
Course Outcomes: At the end of the course, the students should be able to	
1	Describe the basic concepts of Computer Graphics.
2	Demonstrate various algorithms for basic graphics primitives.
3	Apply 2-D geometric transformations on graphical objects.
4	Use various Clipping algorithms on graphical objects
5	Explore 3-D geometric transformations, curve representation techniques and projections methods.
6	Explain visible surface detection techniques and Animation.

Module		Detailed Content	Hours
1		**Introduction and Overview of Graphics System:**	**02**
	1.1	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.	
	1.2	Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems.	
2		**Output Primitives:**	**10**
	2.1	Scan conversions of point, line, circle and ellipse: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected)	
	2.2	Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).	
	2.3	Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm.	
3		**Two Dimensional Geometric Transformations**	**6**
	3.1	Basic transformations: Translation, Scaling, Rotation	
	3.2	Matrix representation and Homogeneous Coordinates	
	3.3	Composite transformation	
	3.4	Other transformations: Reflection and Shear	
4		**Two-Dimensional Viewing and Clipping**	**7**
	4.1	Viewing transformation pipeline and Window to Viewport coordinate transformation	
	4.2	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.	
5		**Three Dimensional Geometric Transformations, Curves and Fractal Generation**	**8**
	5.1	3D Transformations: Translation, Rotation, Scaling and Reflection	

	5.2	Composite transformations: Rotation about an arbitrary axis	
	5.3	Projections – Parallel, Perspective. (Matrix Representation)	
	5.4	Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve.	
6		**Visible Surface Detection and Animation**	**6**
	6.1	Visible Surface Detection: Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method, Area Subdivision method	
	6.2	Animation: Introduction to Animation, Traditional Animation Techniques, Principles of Animation, Key framing: Character and Facial Animation, Deformation, Motion capture	

Textbooks:	
1	Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2nd Edition, Pearson Publication
3	Samit Bhattacharya, "Computer Graphics", Oxford Publication
References:	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-Hill Education
3	Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.
4	F. S. Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links	
1	https://www.classcentral.com/course/interactivegraphics-2067
2	https://swayam.gov.in/nd2_ntr20_ed15/preview
3	https://nptel.ac.in/courses/106/106/106106090/
4	https://www.edx.org/course/computer-graphics-2

Lab Code	Lab Name	Credit
CSL301	Data Structures Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To implement basic data structures such as arrays, linked lists, stacks and queues
2	Solve problem involving graphs, and trees
3	To develop application using data structure algorithms
4	Compute the complexity of various algorithms.
Lab Outcomes:	
1	Students will be able to implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them.
2	Students will be able to implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them
3	Students will be able to choose appropriate data structure and apply it in various problems
4	Students will be able to select appropriate searching techniques for given problems.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	Implement Stack ADT using array.
2*	Convert an Infix expression to Postfix expression using stack ADT.
3*	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.
5*	Implement Linear Queue ADT using array.
6*	Implement Circular Queue ADT using array.
7	Implement Priority Queue ADT using array.
8*	Implement Singly Linked List ADT.
9*	Implement Circular Linked List ADT.
10	Implement Doubly Linked List ADT.
11*	Implement Stack / Linear Queue ADT using Linked List.
12*	Implement Binary Search Tree ADT using Linked List.
13*	Implement Graph Traversal techniques:) Depth First Search b) Breadth First Search
14	Applications of Binary Search Technique.

Useful Links:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSL301and CSC303

Lab Code	Lab Name	Credit
CSL302	Digital Logic & Computer Organization and Architecture Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To implement operations of the arithmetic unit using algorithms.
2	Design and simulate different digital circuits.
3	To design memory subsystem including cache memory.
4	To demonstrate CPU and ALU design.
Lab Outcomes:	
1	To understand the basics of digital components
2	Design the basic building blocks of a computer: ALU, registers, CPU and memory
3	To recognize the importance of digital systems in computer architecture
4	To implement various algorithms for arithmetic operations.

List of Experiments:	
Sr. No.	**Name of the Experiment**
1	To verify the truth table of various logic gates using ICs.
2	To realize the gates using universal gates
3	Code conversion.
4	To realize half adder and full adder.
5	To implement logic operation using MUX IC.
6	To implement logic operation decoder IC.
7	Study of flip flop IC.
8	To implement ripple carry adder.
9	To implement carry look ahead adder.
10	To implement Booth's algorithm.
11	To implement restoring division algorithm.
12	To implement non restoring division algorithm.
13	To implement ALU design.
14	To implement CPU design.
15	To implement memory design.
16	To implement cache memory design.

Note:	
1	Any Four experiments from Exp. No. 1 to Exp. No. 7 using hardware.
2	Any Six experiments from Exp. No. 8 to Exp. No. 16 using Virtual Lab, expect Exp. No 10,11 and 12.
3	Exp. No. 10 to Exp. No. 12 using Programming language.
Digital Material:	
1	Manual to use Virtual Lab simulator for Computer Organization and Architecture developed by the Department of CSE, IIT Kharagpur.
2	Link http://cse10-iitkgp.virtual-labs.ac.in/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Digital Logic &Computer Organization and Architecture"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Course Code	Lab Name	Credits
CSL303	Computer Graphics Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	Understand the need of developing graphics application
2	Learn algorithmic development of graphics primitives like line, circle, polygon etc.
3	Learn the representation and transformation of graphical images and pictures
Lab Outcomes: At the end of the course, the students should be able to	
1	Implement various output and filled area primitive algorithms
2	Apply transformation, projection and clipping algorithms on graphical objects.
3	Perform curve and fractal generation methods.
4	Develop a Graphical application/Animation based on learned concept

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation Curves Visible surface determination. Simple animations Application of these through exercises in C/C++

List of Suggested Experiments:

Sr. No.	Name of the Experiment
1	Implement DDA Line Drawing algorithm (dotted/dashed/thick)
2	Implement Bresenham's Line algorithm(dotted/dashed/thick)
3	Implement midpoint Circle algorithm.
4	Implement midpoint Ellipse algorithm.
5	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.
6	Implement Scan line Polygon Filling algorithm.
7	Implement Curve: Bezier for n control points, B Spline (Uniform)(at least one)
8	Implement Fractal generation method (anyone)
9	Character Generation: Bit Map method and Stroke Method
10	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.
11	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.
12	Implement polygon clipping algorithm (at least one)
13	Program to perform 3D transformation.
14	Perform projection of a 3D object on Projection Plane: Parallel and Perspective.
15	Perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc.)

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments
3	Mini Project to perform using C /C++/Java/OpenGL/Blender/ any other tool (2/3 students per group). Possible Ideas: Animation using multiple objects, Game development, Graphics editor: Like Paint brush, Text editor etc.
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Experiments: 10-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks, Mini Project: 5-marks)
Oral & Practical exam	
	Based on the above contents and entire syllabus of CSC305

Lab Code	Lab Name	Credits
CSL304	Skill based Lab Course: Object Oriented Programming with Java	2

Prerequisite: Structured Programming Approach	
Lab Objectives:	
1	To learn the basic concepts of object-oriented programming
2	To study JAVA programming language
3	To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc.
4	To explain components of GUI based programming.
Lab Outcomes: At the end of the course, the students should be able to	
1	To apply fundamental programming constructs.
2	To illustrate the concept of packages, classes and objects.
3	To elaborate the concept of strings, arrays and vectors.
4	To implement the concept of inheritance and interfaces.
5	To implement the concept of exception handling and multithreading.
6	To develop GUI based application.

Module		Detailed Content	Hours
1		**Introduction to Object Oriented Programming**	**2**
	1.1	OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing.	
	1.2	Java Virtual Machine	
	1.3	Basic programming constructs: variables, data types, operators, unsigned right shift operator, expressions, branching and looping.	
2		**Class, Object, Packages and Input/output**	**6**
	2.1	Class, object, data members, member functions Constructors, types, static members and functions Method overloading Packages in java, types, user defined packages Input and output functions in Java, Buffered reader class, scanner class	
3		**Array, String and Vector**	**3**
	3.1	Array, Strings, String Buffer, Vectors	
4		**Inheritance**	**4**
	4.1	Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritance using interface, extends keyword	
5		**Exception handling and Multithreading**	**5**
	5.1	Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks, user defined exception Thread lifecycle, thread class methods, creating threads using extends and implements keyword.	
6		**GUI programming in JAVA**	**6**
	6.1	Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class AWT: working with windows, using AWT controls for GUI design Swing class in JAVA	

		Introduction to JDBC, JDBC-ODBC connectivity, JDBC architecture.	

Textbooks:	
1	Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2	E. Balagurusamy, 'Programming with Java', McGraw Hill Education.
References:	
1	Ivor Horton, "Beginning JAVA", Wiley India.
2	Dietal and Dietal, "Java: How to Program", 8th Edition, PHI .
3	"JAVA Programming", Black Book, Dreamtech Press.
4	"Learn to Master Java programming", Staredu solutions
Digital material:	
1	www.nptelvideos.in
2	www.w3schools.com
3	www.tutorialspoint.com
4	https://starcertification.org/Certifications/Certificate/securejava

Suggested List of Programming Assignments/laboratory Work:	
Sr. No.	**Name of the Experiment**
1	Programs on Basic programming constructs like branching and looping
2	Program on accepting input through keyboard.
3	Programs on class and objects
4	Program on method and constructor overloading.
5	Program on Packages
6	Program on 2D array, strings functions
7	Program on String Buffer and Vectors
8	Program on types of inheritance
9	Program on Multiple Inheritance
10	Program on abstract class and abstract methods.
11	Program using super and final keyword
12	Program on Exception handling
13	Program on user defined exception
14	Program on Multithreading
15	Program on Graphics class
16	Program on applet class
17	Program to create GUI application
18	Mini Project based on the content of the syllabus (Group of 2-3 students)

Term Work:	
1	Term work should consist of 15 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 50-Marks (Experiments: 15-marks, Attendance: 05-marks, Assignments: 05-marks, Mini Project: 20-marks, MCQ as a part of lab assignments: 5-marks)

Oral & Practical exam
Based on the entire syllabus of CSL 304: **Skill based Lab Course: Object Oriented Programming with Java**

Course code	Course Name	Credits
CSM301	Mini Project A	02

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

	Distribution of Term work marks for both semesters shall be as below:	**Marks**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1	In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group. • First shall be for finalization of problem • Second shall be on finalization of proposed solution of problem.
2	In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. • First review is based on readiness of building working prototype to be conducted. • Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

1	In this case in one semester students' group shall complete project in all aspects including, • Identification of need/problem • Proposed final solution • Procurement of components/systems • Building prototype and testing
2	Two reviews will be conducted for continuous assessment, • First shall be for finalization of problem and proposed solution • Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements

10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual's as member or leader
13	Clarity in written and oral communication
	In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

Course Code	Course Name	Credits
CSC401	Engineering Mathematics-IV	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.	
Course Objectives: The course aims to learn:	
1	Matrix algebra to understand engineering problems.
2	Line and Contour integrals and expansion of a complex valued function in a power series.
3	Z-Transforms and Inverse Z-Transforms with its properties.
4	The concepts of probability distributions and sampling theory for small samples.
5	Linear and Non-linear programming problems of optimization.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Apply the concepts of eigenvalues and eigenvectors in engineering problems.
2	Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3	Apply the concept of Z- transformation and inverse in engineering problems.
4	Use the concept of probability distribution and sampling theory to engineering problems.
5	Apply the concept of Linear Programming Problems to optimization.
6	Solve Non-Linear Programming Problems for optimization of engineering problems.

Module		Detailed Contents	Hours
1	**Linear Algebra (Theory of Matrices)**		7
	1.1	Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof)	
	1.2	Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials	
	1.3	Similarity of matrices, diagonalizable and non-diagonalizable matrices	
	1.4	**Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	
2	**Complex Integration**		7
	2.1	Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof).	
	2.2	Taylor's and Laurent's series (without proof).	
	2.3	Definition of Singularity, Zeroes, poles of*f(z)*, Residues, Cauchy's Residue Theorem (without proof)	
	2.4	**Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	
3	**Z Transform**		5
	3.1	Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}, \{a^{\lvert k\rvert}\}, \{{}^{k+n}_{n}C.\, a^k\}, \{c^k \sin(\alpha k+\beta)\}, \{c^k \sinh \alpha k\}, \{c^k \cosh \alpha k\}$.	
	3.2	Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem.	
	3.3	Inverse Z transform: Partial Fraction Method, Convolution Method.	
	3.4	**Self-learning Topics:** Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	
4	**Probability Distribution and Sampling Theory**		7
	4.1	Probability Distribution: Poisson and Normal distribution	

	4.2	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom.	
	4.3	Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table.	
	4.4	**Self-learning Topics:** Test significance for Large samples, Estimate parameters of a population, Yate's Correction.	
5	**Linear Programming Problems**		6
	5.1	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method.	
	5.2	Artificial variables, Big-M method (Method of penalty)	
	5.3	Duality, Dual of LPP and Dual Simplex Method	
	5.4	**Self-learning Topics:** Sensitivity Analysis, Two-Phase Simplex Method, Revised Simplex Method.	
6	**Nonlinear Programming Problems**		7
	6.1	NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers	
	6.2	NLPP with two equality constraints	
	6.3	NLPP with inequality constraint: Kuhn-Tucker conditions	
	6.4	**Self-learning Topics:** Problems with two inequality constraints, Unconstrained optimization: One-dimensional search method (Golden Search method, Newton's method). Gradient Search method	

References:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons.
2	R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa.
3	Brown and Churchill, "Complex Variables and Applications", McGraw-Hill Education.
4	T. Veerarajan, "Probability, Statistics and Random Processes", McGraw-Hill Education.
5	Hamdy A Taha, "Operations Research: An Introduction", Pearson.
6	S.S. Rao, "Engineering Optimization: Theory and Practice", Wiley-Blackwell.
7	Hira and Gupta, "Operations Research", S. Chand Publication.

Term Work:		
General Instructions:		
1	Batch wise tutorial shave to be conducted. The number of students per batch will be as per University pattern for practical.	
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.	
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.	
The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

<u>Assessment</u>:
Internal Assessment Test:
The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is

completed. The duration of each test will be for one hour.	
End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Credit
CSC402	Analysis of Algorithms	3

Prerequisite: Data structure concepts, Discrete structures	
Course Objectives:	
1	To provide mathematical approaches for Analysis of Algorithms
2	To understand and solve problems using various algorithmic approaches
3	To analyze algorithms using various methods
Course Outcomes: At the end of the course learner will be able to	
1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

Module		Detailed Contents	Hours
1		**Introduction**	8
	1.1	Performance analysis, space, and time complexity Growth of function, Big-Oh, Omega Theta notation Mathematical background for algorithm analysis. Complexity class: Definition of P, NP, NP-Hard, NP-Complete Analysis of selection sort, insertion sort.	
	1.2	Recurrences: The substitution method, Recursion tree method, Master method	
2		**Divide and Conquer Approach**	6
	2.1	General method, Merge sort, Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	
3		**Greedy Method Approach**	6
	3.1	General Method, Single source shortest path: Dijkstra Algorithm Fractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms	
4		**Dynamic Programming Approach**	9
	4.1	General Method, Multistage graphs, Single source shortest path: Bellman Ford Algorithm All pair shortest path: Floyd Warshall Algorithm, Assembly-line scheduling Problem0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence	
5		**Backtracking and Branch and bound**	6
	5.1	General Method, Backtracking: N-queen problem, Sum of subsets, Graph coloring	
	5.2	Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem	
6		**String Matching Algorithms**	4
	6.1	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	

Textbooks:	
1	T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2	Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

References:	
1	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw-Hill Edition.
2	S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

Course Code:	Course Title	Credit
CSC403	Database Management System	3

Prerequisite: Data Structures	
Course Objectives:	
1	Develop entity relationship data model and its mapping to relational model
2	Learn relational algebra and Formulate SQL queries
3	Apply normalization techniques to normalize the database
4	Understand concept of transaction, concurrency control and recovery techniques.
Course Outcomes:	
1	Recognize the need of database management system
2	Design ER and EER diagram for real life applications
3	Construct relational model and write relational algebra queries.
4	Formulate SQL queries
5	Apply the concept of normalization to relational database design.
6	Describe the concept of transaction, concurrency and recovery.

Module		Content	Hrs
1		**Introduction Database Concepts**	**3**
	1.1	Introduction, Characteristics of databases, File system v/s Database system, Data abstraction and data Independence, DBMS system architecture, Database Administrator	
2		**Entity–Relationship Data Model**	**6**
	2.1	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		**Relational Model and relational Algebra**	**8**
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model, Relational Algebra-operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	**6**
	4.1	Overview of SQL, Data Definition Commands, Integrity constraints: key constraints, Domain Constraints, Referential integrity , check constraints, Data Manipulation commands, Data Control commands, Set and string operations, aggregate function-group by, having, Views in SQL, joins, Nested and complex queries, Triggers	
5		**Relational-Database Design**	**6**
	5.1	Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	**10**
	6.1	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery, Deadlock handling	

Textbooks:	
1	Korth, Slberchatz, Sudarshan, Database System Concepts, 6thEdition, McGraw Hill
2	Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, Pearson Education
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
References:	
1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5thEdition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	G. K. Gupta, Database Management Systems, McGraw Hill, 2012

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105175/
2	https://swayam.gov.in/nd1_noc19_cs46/preview
3	https://www.classcentral.com/course/swayam-database-management-system-9914
4	https://www.mooc-list.com/tags/dbms

Course Code	Course Name	Credit
CSC404	Operating System	03

Prerequisites: Data structures and Computer architecture	
Course Objectives:	
1	1. To introduce basic concepts and functions of operating systems.
2	2. To understand the concept of process, thread and resource management.
3	3. To understand the concepts of process synchronization and deadlock.
4	4. To understand various Memory, I/O and File management techniques.
Course Outcome:	
1	Understand the objectives, functions and structure of OS
2	Analyze the concept of process management and evaluate performance of processscheduling algorithms.
3	Understand and apply the concepts of synchronization and deadlocks
4	Evaluate performance of Memory allocation and replacement policies
5	Understand the concepts of file management.
	Apply concepts of I/O management and analyze techniques of disk scheduling.

Module	Detailed Content		Hours
1	**Operating system Overview**		**4**
	1.1	Introduction, Objectives, Functions and Evolution of Operating System	
	1.2	Operating system structures: Layered, Monolithic and Microkernel	
	1.3	Linux Kernel, Shell and System Calls	
2	**Process and Process Scheduling**		**9**
	2.1	Concept of a Process, Process States, Process Description, Process Control Block.	
	2.2	Uniprocessor Scheduling-Types: Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority, RR)	
	2.3	Threads: Definition and Types, Concept of Multithreading	
3	**Process Synchronization and Deadlocks**		**9**
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	
	3.2	Mutual Exclusion: Requirements, Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem.	
	3.3	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker‟s Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	
4	**Memory Management**		**9**
	4.1	Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation, TLB	
	4.2	Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU, Thrashing	
5		**File Management**	**4**

	5.1	Overview, File Organization and Access, File Directories, File Sharing	
6		**I/O management**	**4**
	6.1	I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK.	

Textbooks:	
1	William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918.
2	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
References:	
1	Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition
2	Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.
3	Maurice J. Bach, "Design of UNIX Operating System", PHI
4	Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links	
1	https://swayam.gov.in/nd1_noc19_cs50/preview
2	https://nptel.ac.in/courses/117/106/117106113/
3	https://www.classcentral.com/course/swayam-introduction-to-operating-systems-6559

Course Code	Course Name	Credits
CSC405	**Microprocessor**	**3**

Prerequisites: Digital Logic and Computer Architecture	
Course objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in thefield of Microprocessors.
2	To emphasize on instruction set and logic to build assembly language programs.
3	To prepare students for higher processor architectures and embedded systems
Course outcomes: On successful completion of course, learner will be able to:	
1	Describe core concepts of 8086 microprocessor.
2	Interpret the instructions of 8086 and write assembly and Mixed language programs.
3	Identify the specifications of peripheral chip.
4	Design 8086 based system using memory and peripheral chips.
5	Appraise the architecture of advanced processors
6	Understand hyperthreading technology

Module	**Detailed Contents**		**Hours**
1	**The Intel Microprocessors 8086 Architecture**		8
	1.1	8086CPU Architecture,	
	1.2	Programmer's Model	
	1.3	Functional Pin Diagram	
	1.4	Memory Segmentation	
	1.5	Banking in 8086	
	1.6	Demultiplexing of Address/Data bus	
	1.7	Functioning of 8086 in Minimum mode and Maximum mode	
	1.8	Timing diagrams for Read and Write operations in minimum and maximum mode	
	1.9	Interrupt structure and its servicing	
2	**Instruction Set and Programming**		**6**
	2.1	Addressing Modes	
	2.2	Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
	2.3	Assembler Directives and Assembly Language Programming, Macros, Procedures	
3	**Memory and Peripherals interfacing**		**8**
	3.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2	8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3	8257-DMAC-Block diagram, DMA operations and transfer modes.	
	3.4	Programmable Interrupt Controller 8259-Block Diagram, Interfacing the 8259 in single and cascaded mode.	
4	**Intel 80386DX Processor**		**7**
	4.1	Architecture of 80386 microprocessor	
	4.2	80386 registers–General purpose Registers, EFLAGS and Control	

		registers	
	4.3	Real mode, Protected mode, virtual 8086 mode	
	4.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
5	**Pentium Processor**		**6**
	5.1	Pentium Architecture	
	5.2	Superscalar Operation,	
	5.3	Integer &Floating-Point Pipeline Stages,	
	5.4	Branch Prediction Logic,	
	5.5	Cache Organization and	
	5.6	MESI protocol	
6	**Pentium 4**		**4**
	6.1	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium III	
	6.2	Pentium 4: Net burst micro architecture.	
	6.3	Instruction translation look aside buffer and branch prediction	
	6.4	Hyper threading technology and its use in Pentium 4	

Textbooks:	
1	John Uffenbeck, “8086/8088 family: Design Programming and Interfacing”, PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, “Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design”, Prentice Hall
3	Walter A. Triebel, “The 80386DX Microprocessor: hardware, Software and Interfacing”, Prentice Hall
4	Tom Shanley and Don Anderson, “Pentium Processor System Architecture”, Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, “Advanced Microprocessors and Peripherals”, McGraw Hill
References:	
1	Barry B. Brey, “Intel Microprocessors”, 8thEdition, Pearson Education India
2	Douglas Hall, “Microprocessor and Interfacing”, Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, “IBM PC Assembly language and Programming”, 5th Edition, PHI
5	James Antonakons, “The Pentium Microprocessor”, Pearson Education

Assessment:
Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.
End Semester Theory Examination:
1 Question paper will comprise of 6 questions, each carrying 20 marks.
2 The students need to solve total 4 questions.
3 Question No.1 will be compulsory and based on entire syllabus.
4 Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://swayam.gov.in/nd1_noc20_ee11/preview
2	https://nptel.ac.in/courses/108/105/108105102/
3	https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894
4	https://www.mooc-list.com/tags/microprocessors

Course Name	Lab Name	Credit
CSL401	**Analysis of Algorithms Lab**	**1**

Prerequisite: Basic knowledge of programming and data structure	
Lab Objectives:	
1	To introduce the methods of designing and analyzing algorithms
2	Design and implement efficient algorithms for a specified application
3	Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4	Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.
Lab Outcomes: At the end of the course, the students will be able to	
1	Implement the algorithms using different approaches.
2	Analyze the complexities of various algorithms.
3	Compare the complexity of the algorithms for specific problem.

Description		
Implementation can be in any language.		
Suggested Practical List:		
Sr No		**Suggested Experiment List**
1		**Introduction**
	1.1	Selection sort, Insertion sort
2		**Divide and Conquer Approach**
	2.1	Finding Minimum and Maximum, Merge sort, Quick sort, Binary search
3		**Greedy Method Approach**
	3.1	Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm
4		**Dynamic Programming Approach**
	4.1	Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Travelling salesperson problem Longest common subsequence
5		**Backtracking and Branch and bound**
	5.1	N-queen problem Sum of subsets Graph coloring
6		**String Matching Algorithms**
	6.1	The Naïve string-matching Algorithms The Rabin Karp algorithm The Knuth-Morris-Pratt algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Analysis of Algorithms"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC402: Analysis of Algorithms

Lab Code	Lab Name	Credit
CSL402	Database Management system Lab	1

Prerequisite: Discrete Structures	
Lab Objectives:	
1	To explore design and develop of relational model
2	To present SQL and procedural interfaces to SQL comprehensively
3	To introduce the concepts of transactions and transaction processing
Lab Outcomes: At the end of the course, the students will be able to	
1	Design ER /EER diagram and convert to relational model for the realworld application.
2	Apply DDL, DML, DCL and TCL commands
3	Write simple and complex queries
4	UsePL / SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions
10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Database Management System”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	

Course Code	Course Name	Credit
CSL403	Operating System Lab	01
	Based on the entire syllabus of CSC403: Database Management System	

Prerequisite: Knowledge on Operating system principles	
Lab Objectives:	
1	To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment.
2	To familiarize students with the architecture of Linux OS.
3	To provide necessary skills for developing and debugging programs in Linux environment.
4	To learn programmatically to implement simple operation system mechanisms
Lab Outcomes: At the end of the course, the students will be able to	
1	Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrt Linux
2	Implement various process scheduling algorithms and evaluate their performance.
3	Implement and analyze concepts of synchronization and deadlocks.
4	Implement various Memory Management techniques and evaluate their performance.
5	Implement and analyze concepts of virtual memory.
6	Demonstrate and analyze concepts of file management and I/O management techniques.

Suggested List of Experiments		
Sr. No.		**Content**
1		**Explore Linux Commands**
	1.1	**Explore usage of basic Linux Commands and system calls for file, directory and process management.** For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.)
2		**Linux shell script**
	2.1	Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. Display current shell, home directory, operating system type, current path setting, current working directory.
3		**Linux- API**
	3.1	Implement any one basic commands of linux like ls, cp, mv and others using kernel APIs.
4		**Linux- Process**
	4.1	a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. b. Explore wait and waitpid before termination of process.
5		**Process Management: Scheduling**

	5.1	a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms
6		**Process Management: Synchronization**
	6.1	**a.** Write a C program to implement solution of Producer consumer problem through Semaphore
7		**Process Management: Deadlock**
	7.1	a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm b. Write a program demonstrate the concept of Dining Philospher's Problem
8		**Memory Management**
	8.1	a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.
9		**Memory Management: Virtual Memory**
	9.1	a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.
10		**File Management & I/O Management**
	10.1	a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. **c.** Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN

Term Work:	
1	Term work should consist of 10 experiments covering all modules.
2	Journal must include at least 2 assignments on content of theory and practical of "Database Management System"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC405: Operating System.

Lab Code	Lab Name	Credits
CSL404	**Microprocessor Lab**	**1**

Prerequisite: Basic knowledge digital integrated circuits	
Lab Objectives:	
1	To emphasize on use of Assembly language program.
2	To prepare students for advanced subjects like embedded system and IOT.
Lab Outcomes: At the end of the course, the students will be able to	
1	Use appropriate instructions to program microprocessor to perform various task
2	Develop the program in assembly/ mixed language for Intel 8086 processor
3	Demonstrate the execution and debugging of assembly/ mixed language program

Suggested List of Experiments:	
Sr. No.	**Title of Experiments**
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8-bit/16-bit data
2	Code conversion (Hex to BCD and BCD to Hex)/ (ASCII to BCD and BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Any Mixed Language programs.
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order
9	Any program using INT 10H
10	Assembly program to find minimum/ maximum number from a given array.
11	Assembly Program to display a message in different color with blinking
12	Assembly program using procedure.
13	Assembly program using macro.
14	Program and interfacing using 8255.
15	Program and interfacing of ADC/ DAC/ Stepper motor.

Term Work:	
1	Term work should consist of 10 experiments, out of theses at least one experiment on hardware interfacing.
2	Journal must include at least 2 assignments on content of theory and practical of "Microprocessor"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSL501and CSC501syllabus.

Lab Code	Lab Name	Credit
CSL405	Skill Base Lab Course: Python Programming	2

Prerequisite: Knowledge of some programming language like C, Java	
Lab Objectives:	
1	Basics of Python programming
2	Decision Making, Data structure and Functions in Python
3	Object Oriented Programming using Python
4	Web framework for developing
Lab Outcomes: At the end of the course, the students will be able to	
1	To understand basic concepts in python.
2	To explore contents of files, directories and text processing with python
3	To develop program for data structure using built in functions in python.
4	To explore django web framework for developing python-based web application.
5	To understand Multithreading concepts using python.

Module		Detailed Content	Hours
1		**Python basics**	**5**
	1.1	Data types in python, Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes, Objects, Interfaces, Inheritance	
2		**Advanced Python**	**4**
	2.1	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.	
3		**Data Structure in Python**	**3**
	3.1	Link List, Stack, Queues, Dequeues	
4		**Python Integration Primer**	**4**
	4.1	Graphical User interface, Networking in Python, Python database connectivity, Introduction to Django	
5		**Multithreading**	**4**
	5.1	Thread and Process, Starting a thread, Threading module, Synchronizing threads, Multithreaded Priority Queue	
6		**NumPy and Pandas**	**6**
	6.1	Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types, Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O	
	6.2	Basics of Pandas, Using multilevel series, Series and Data Frames, Grouping, aggregating, Merge Data Frames	

Textbooks:	
1	Dr. R. Nageswara Rao, “Core Python Programming”, Dreamtech Press
2	Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication
3	Anurag Gupta, G. P. Biswas, “Python Programming”, McGraw-Hill
4	E. Balagurusamy, “Introduction to computing and problem-solving using python”, McGraw Hill Education
References:	
1	Learn Python the Hard Way, 3rd Edition, Zed Shaw's Hard Way Series

2	Laura Cassell, Alan Gauld, “Python Projects”, Wrox Publication

Digital material:

1	"The Python Tutorial",http://docs.python.org/release/3.0.1/tutorial/
2	Beginning Perl,https://www.perl.org/books/beginning-perl/
3	http://spoken-tutorial.org
4	https://starcertification.org/Certifications/Certificate/python

Suggested experiments using Python:	
Sr. No.	**Title of Experiments**
1	Exploring basics of python like data types (strings, list, array, dictionaries, set, tuples) and control statements.
2	Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
3	Exploring Files and directories a. Python program to append data to existing file and then display the entire file b. Python program to count number of lines, words and characters in a file. c. Python program to display file available in current directory
4	Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
5	Menu driven program for data structure using built in function for link list, stack and queue.
6	Program to demonstrate CRUD (**create, read, update and delete)** operations on database (SQLite/ MySQL) using python.
7	Creation of simple socket for basic information exchange between server and client.
8	Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).
9	Programs on Threading using python.
10	Exploring basics of NumPy Methods.
11	Program to demonstrate use of NumPy: Array objects.
12	Program to demonstrate Data Series and Data Frames using Pandas.
13	Program to send email and read content of URL.

Term Work:	
1	Term work should consist of 12 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Journal: 10-marks, Attendance: 05-marks, and Mini Project: 10-marks)

Course code	Course Name	Credits
CSM401	Mini Project B	02

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

	Distribution of Term work marks for both semesters shall be as below:	**Marks**
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1	In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group. • First shall be for finalization of problem • Second shall be on finalization of proposed solution of problem.
2	In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. • First review is based on readiness of building working prototype to be conducted. • Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

1	In this case in one semester students' group shall complete project in all aspects including, • Identification of need/problem • Proposed final solution • Procurement of components/systems • Building prototype and testing
2	Two reviews will be conducted for continuous assessment, • First shall be for finalization of problem and proposed solution • Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness

8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual's as member or leader
13	Clarity in written and oral communication
	In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

AC – 5th May, 2018

Item No. – 4.51

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To equip the Learner with broad education necessary to understand the impact of Computer Science and Engineering in a global and social context.
4. To encourage, motivate and prepare the Learner's for Lifelong- learning.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. Subhash K. Shinde
Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1		1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	**20**	**14**	-	**20**	**7**	-	**27**

@ 1 hour to be taken tutorial as class wise.
*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
Total		100	100	100	400	-	150	100	750

Sem.	Department Level Optional Course (DLOC)	Institute Level Optional Course (ILOC)
V	CSDLO5011: Multimedia System CSDLO5012: Advance Operating System CSDLO5013: Advance Algorithm	----------
VI	CSDLO6021: Machine Learning CSDLO6022: Advance Database System CSDLO6023: Enterprise Resource Planning CSDLO6024: Advance Computer Network	----------
VII	CSDLO7031: Advance System Security & Digital Forensics CSDLO7032: Big Data & Analytics CSDLO7033: Robotics	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering
VIII	DLO8011: High Performance Computing DLO8012: Natural Language Processing DLO8013: Adhoc Wireless Network	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Name	Credits
CSC501	Microprocessor	4

Course objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
2. To emphasize on instruction set and logic to build assembly language programs.
3. To prepare students for higher processor architectures and Embedded systems

Course outcomes: On successful completion of course learner will be able to:

1. Describe architecture of x86 processors.
2. Interpret the instructions of 8086 and write assembly and Mixed language programs.
3. Explain the concept of interrupts
4. Identify the specifications of peripheral chip
5. Design 8086 based system using memory and peripheral chips
6. Appraise the architecture of advanced processors

Prerequisite: Digital Electronics and Logic Design

Module No.	Unit No.	Topics	Hrs.
1.0		**The Intel Microprocessors 8086/8088 Architecture**	10
	1.1	• 8086/8088 CPU Architecture, Programmer's Model • Functional Pin Diagram • Memory Segmentation • Banking in 8086 • Demultiplexing of Address/Data bus • Study of 8284 Clock Generator • Study of 8288 Bus Controller • Functioning of 8086 in Minimum mode and Maximum mode • Timing diagrams for Read and Write operations in minimum and maximum mode	
2.0		**Instruction Set and Programming**	12
	2.1	• Addressing Modes • Instruction set – Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions • Assembler Directives and Assembly Language Programming, Macros, Procedures • Mixed Language Programming with C Language and Assembly Language. • Programming based on DOS and BIOS Interrupts (INT 21H, INT 10H)	
3.0		**8086 Interrupts**	6
	3.1	• Types of interrupts • Interrupt Service Routine • Interrupt Vector Table • Servicing of Interrupts by 8086 microprocessor • Programmable Interrupt Controller 8259 – Block Diagram, Interfacing the 8259 in single and cascaded mode, Operating modes, programs for 8259 using ICWs and OCWs	

4.0		**Peripherals and their interfacing with 8086**	**12**
	4.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	4.2	8255-PPI – Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.3	8253 PIT - Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.4	8257-DMAC – Block diagram, Functional PIN Diagram, Register organization, DMA operations and transfer modes	
5.0		**Intel 80386DX Processor**	**6**
	5.1	• Architecture of 80386 microprocessor • 80386 registers – General purpose Registers, EFLAGS and Control registers • Real mode, Protected mode, virtual 8086 mode • 80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
6.0		**Pentium Processor**	**6**
	6.1	Pentium Architecture Superscalar Operation, Integer & Floating Point Pipeline Stages, Branch Prediction Logic, Cache Organisation and MESI Model	
		Total	**52**

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1 Question paper will comprise of 6 questions, each carrying 20 marks.
1. The students need to solve total 4 questions.
2. Question No.1 will be compulsory and based on entire syllabus.
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:
1. 8086/8088 family: Design Programming and Interfacing: John Uffenbeck , PHI.
2. Advanced Microprocessors and Peripherals: K M Bhurchandani, A k Ray McGraw Hill
3. The 80386DX Microprocessor: hardware, Software and Interfacing, Walter A Triebel, Prentice Hall
4. Pentium Processor System Architecture: Tom Shanley & Don Anderson, Addison-Wesley.

Reference Books:

1. Intel Microprocessors: Barry B. Brey, 8th Edition, Pearson Education India
2. Microprocessor and Interfacing: Douglas Hall, Tata McGraw Hill.
3. Advanced MS DOS Programming – Ray Duncan BPB
4. Intel 80386 Datasheets
5. IBM PC Assembly language and Programming: Peter Abel, 5th edition, PHI
6. The Pentium Microprocessor, James Antonakons, Pearson Education

Course Code	Course Name	Credits
CSC502	Database Management System	4

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Prerequisite:

Basic knowledge of Data structure.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction Database Concepts:**	**4**
	1.1	● Introduction, Characteristics of databases ● File system v/s Database system ● Users of Database system	
	1.2	● Data Independence ● DBMS system architecture ● Database Administrator	
2.0		**Entity–Relationship Data Model**	**8**
	2.1	● The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation	
3.0		**Relational Model and relational Algebra**	**8**
	3.1	● Introduction to the Relational Model, relational schema and concept of keys. ● Mapping the ER and EER Model to the Relational Model	
	3.2	● Relational Algebra – unary and set operations, Relational Algebra Queries.	
4.0		**Structured Query Language (SQL)**	**12**
	4.1	● Overview of SQL	

		• Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	
	4.2	• Set and string operations, aggregate function - group by, having. • Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints	
	4.3	• Triggers	
5.0		**Relational–Database Design**	**8**
	5.1	• Pitfalls in Relational-Database designs , Concept of normalization • Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF.	
6.0		**Transactions Management and Concurrency**	**12**
	6.1	• Transaction concept, Transaction states, ACID properties • Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	
	6.2	• Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. • Deadlock handling	
		Total	**52**

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. G. K. Gupta "Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley Publication.
3. Sharaman Shah, "Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems ",TMH.

Course Code	Course Name	Credits
CSC 503	**Computer Network**	**4**

Course objective:

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand the transport layer and various application layer protocols.

Course Outcomes:

On successful completion of course learner will be able to:

1. Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2. Demonstrate the knowledge of networking protocols at data link layer.
3. Design the network using IP addressing and subnetting / supernetting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer .

Prerequisite: Digital Communication Fundamentals

Module No.	Unit No.	Topics	Hrs.
1	**Introduction to Networking**		06
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layer.	
2	**Physical Layer**		06
	2.1	Introduction to Communication System, digital Communication, Electromagnetic Spectrum	
	2.2	**Guided Transmission Media:** Twisted pair, Coaxial, Fiber optics. Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	

3	**Data Link Layer**		10
	3.1	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC	
	3.2	**Medium Access Control sublayer** Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3)	
4	**Network layer**		14
	4.1	4.1 Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT)	
	4.2	**Routing algorithms :** Shortest Path (Dijkastra's), Link state routing, Distance Vector Routing	
	4.3	**Protocols** - ARP,RARP, ICMP, IGMP	
	4.4	**Congestion control algorithms:** Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5	**Transport Layer**		10
	5.1	**The Transport Service**: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6	**Application Layer**		06
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Textbooks:

1. A.S. Tanenbaum, "Computer Networks", Pearson Education, (4e)
2. B.A. Forouzan, "Data Communications and Networking", TMH (5e)
3. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Addison Wesley, (6e)

References:

1. S.Keshav: An Engineering Approach To Computer Networking, Pearson
2. Natalia Olifer& Victor Olifer,"Computer Networks:Principles, Technologies & Protocols for Network Design", Wiley India, 2011.
3. Larry L.Peterson, Bruce S.Davie, Computer Networks: A Systems Approach, Second Edition (The Morgan Kaufmann Series in Networking).

Course Code	Course Name	Credits
CSC504	Theory of Computer Science	4

Course Objectives:

1. Acquire conceptual understanding of fundamentals of grammars and languages.
2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3. Develop understanding of different types of Turing machines and applications.
4. Understand the concept of Undecidability.

Course Outcomes: On successful completion of course learner will be able to:

1. Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.
2. Infer the equivalence of languages described by finite automata and regular expressions.
3. Devise regular, context free grammars while recognizing the strings and tokens.
4. Design pushdown automata to recognize the language.
5. Develop an understanding of computation through Turing Machine.
6. Acquire fundamental understanding of decidability and undecidability.

Prerequisite: Discrete Mathematics

Module No.	Unit No.	Topics	Theory Hrs.	Tutorial Hrs.
1.0		**Basic Concepts and Finite Automata**	**09**	**03**
	1.1	• Alphabets, Strings, Languages, Closure properties. • Finite Automata (FA) and Finite State machine (FSM).		
	1.2	• Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers • NFA to DFA Conversion • Equivalence between NFA with and without ε- transitions • Minimization of DFA • FSM with output: Moore and Mealy machines, Equivalence • Applications and limitations of FA		
2.0		**Regular Expressions and Languages**	**06**	**02**
	2.1	• Regular Expression (RE) • Equivalence of RE and FA, Arden's Theorem • RE Applications		
	2.2	• Regular Language (RL) • Closure properties of RLs • Decision properties of RLs • Pumping lemma for RLs		
3.0		**Grammars**	**08**	**03**
	3.1	• Grammars and Chomsky hierarchy		
	3.2	• Regular Grammar (RG)		

		• Equivalence of Left and Right linear grammar • Equivalence of RG and FA		
	3.3	**Context Free Grammars (CFG)** • Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity. • Simplification and Applications. • Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF). • CFLs - Pumping lemma, Closure properties		
4.0		**Pushdown Automata(PDA)**	**04**	**01**
	4.1	• Definition, Transitions ,Language of PDA • Language acceptance by final state and empty stack • PDA as generator, decider and acceptor of CFG. • Deterministic PDA , Non-Deterministic PDA • Application of PDA.		
5.0		**Turing Machine (TM)**	**09**	**03**
	5.1	• Definition, Transitions • Design of TM as generator, decider and acceptor. • Variants of TM: Multitrack, Multitape • Universal TM. • Equivalence of Single and Multi Tape TMs. • Applications, Power and Limitations of TMs. • Context Sensitivity and Linear Bound Automata.		
6.0		**Undecidability**	**03**	**01**
	6.1	• Decidability and Undecidability, • Recursive and Recursively Enumerable Languages. • Halting Problem, • Rice's Theorem, • Post Correspondence Problem,		
		Total	**39**	**13**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, “Introduction to Automata Theory, Languages andComputation”, Pearson Education.
2. Michael Sipser, “Theory of Computation”, Cengage learning.
3. Vivek Kulkarni, “Theory of Computation”, Oxford University Press, India.

Reference Books:

1. J. C. Martin, “Introduction to Languages and the Theory of Computation”, Tata McGraw Hill.
2. Kavi Mahesh, “Theory of Computation: A Problem Solving Approach”, Wiley-India.

Course Code	Course Name	Credits
CSDLO5011	**Multimedia System**	**4**

Course objectives:

1. To introduce students about basic fundamentals and key aspects of Multimedia system.
2. To provide knowledge of compression techniques of different multimedia components
3. To help students to understand multimedia communication standards along with technology environment
4. To provide an opportunity to gain hands-on experience in building multimedia applications.

Course outcomes: Learner will be able to

1. To identify basics of multimedia and multimedia system architecture.
2. To understand different multimedia components.
3. To explain file formats for different multimedia components.
4. To analyze the different compression algorithms.
5. To describe various multimedia communication techniques.
6. To apply different security techniques in multimedia environment.

Prerequisite: Computer Fundaments and Graphics.

Module No.	Unit No.	Topics	Hrs.
1	**Introduction to Multimedia**		8
	1.1	Overview	
	1.2	Objects and Elements of Multimedia	
	1.3	Applications of Multimedia	
	1.4	Multimedia Systems Architecture – IMA, Workstation, Network	
	1.5	Types of Medium (Perception, Representation-..)	
	1.6	Interaction Techniques	
	1.7	I/O devices - Salient features (Electronic Pen , Scanner, Digital Camera, Printers, plotters), Storage Media (Jukebox, DVD), Multimedia Databases	
2	**Text & Digital Image**		10
	Text		
	2.1	Visual Representation, Digital Representation.	
	2.2	File Formats: RTF, TIFF.	
	2.3	Compression Techniques : Huffman Coding, RLE, CCITT group 3 1D	

	Digital Image		
	2.4	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), examples of images (X-Ray, fractal, synthetic, acoustic).	
	2.5	File formats: BMP, JPG	
	2.6	Compression Techniques: fundamentals (coding, interpixel and psychovisual redundancies),Types – lossless and lossy, Lossless Compression Algorithms– Shannon-Fano, CCITT group 4 2D, Lossy Compression Algorithm – JPEG	
3	**Digital Audio**		8
	3.1	Basic Sound Concepts: computer representation of sound,	
	3.2	File Formats – WAV, MPEG Audio	
	3.3	Compression: PCM, DM, DPCM	
4	**Digital Video**		8
	4.1	Digitization of Video, types of video signals (component, composite and S-video),	
	4.2	File Formats: MPEG Video, H.261	
	4.3	Compression: MPEG	
5	**Multimedia Network Communication and Representation**		10
	5.1	Quality of Service	
	5.2	Multimedia over IP (RTP, RTSP, RTCP,RSVP)	
	5.3	Representation- Authoring systems and user interface	
6	**Multimedia Security**		8
	6.1	Requirements and properties	
	6.2	Mechanisms – Digital Signatures, Steganographic methods	
	6.3	Sample applications – unidirectional distributed systems, information systems and conference systems	
		Total	**52**

Text Books:

1. Multimedia System Design, Prabhat K. Andleigh& Kiran Thakrar, PHI.
2. Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic&Dragorad A. Milovanovic, TMH.
3. Multimedia Systems, K. Buford, PHI.
4. Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

Reference Books:

1. Multimedia Computing Communications & Applications, Ralf Steinmetz & Klara Nahrstedt, Pearson.
2. Digital Image processing, Rafael C. Gonzalez, Richard E. Woods, Pearson.
3. Multimedia Applications, Ralf Steinmetz & Klara Nahrstedt, Springer International Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested List of Experiments:

1. Create a new file format to store a multimedia data.
2. Implement a compression technique and check the efficiency on different inputs.
3. To develop a theme based multimedia presentation
4. To add a digital signature onto a document
5. To perform steganography of text onto an image and check the efficiency with different inputs.

** Perform laboratory work of this course in ‘CSL504: Web Design Lab’ as experiments or mini project.

Course Code	Course Name	Credits
CSDLO5012	**Advanced Operating Systems**	4

Course Objectives:

1. To understand design issues of Advanced Operating systems.
2. To understand the architecture, kernel and file management of Unix operating system.
3. To understand basic concepts and need of Distributed operating systems.
4. To understand concepts and working of different advanced Operating systems like Multiprocessor OS, Real time OS, Mobile OS.

Course Outcomes: On successful completion of the course student should be able to

1. Demonstrate understanding of design issues of Advanced operating systems and compare different types of operating systems.
2. Analyse design aspects and data structures used for file subsystem, memory subsystem and process subsystem of Unix OS.
3. Demonstrate understanding of different architectures used in Multiprocessor OS and analyse the design and data structures used in Multiprocessor operating systems.
4. Differentiate between threads and processes and compare different processor scheduling algorithms used in Multiprocessor OS
5. Classify Real Time OS and analyse various real time scheduling algorithms.
6. Explore architectures and design issues of Mobile OS,Virtual OS, Cloud OS.

Prerequisite: Operating Systems

Module	Unit	Detailed Content	Hrs
1		Introduction	04
		Functions of operating systems, Design approaches: layered, kernel based and virtual machine approach, types of advanced operating systems (NOS, DOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS)	
2		Unix Kernel and File Management	14
	2.1	System Structure, User Perspective, Architecture of Unix Operating System	
	2.2	Buffer cache: Header, Buffer Pool, Retrieving, Reading and Writing Buffer	
	2.3	File Representation: inodes: Structure of file Directories, Path conversion to inode, superblock, inode assignment, allocation of disk blocks	
3		Unix Process and Memory management	12
	3.1	Detailed design of Process Structure: Kernel Data structures for process, Structure of Uarea and Process table, Process states and Transitions	
	3.2	Context of a Process: Static and Dynamic area of context, Saving the Context Layout of System Memory, Regions, Mapping regions	

		with Process, page table and mapping virtual address to physical address.	
4		Distributed Operating system concepts	06
		Goals, Distributed Computing Models, Hardware Concepts, Software Concepts, Architecture of DOS. Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, fault tolerance	
5		Multiprocessor Operating System	08
	5.1	Introduction, Basic multiprocessor system architectures, design issues, Threads, Process synchronization: the test and set instruction, the swap instruction, implementation of the process wait	
	5.2	Processor scheduling: Issues, Co-scheduling, Smart scheduling, Affinity Based scheduling	
6		Real Time Operating Systems and Mobile OS	08
	6.1	Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Scheduling in RTOS: Clock driven: cyclic, Event driven: EDF and rate monotonic scheduling.	
	6.2	Mobile OS: Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design issues	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. The Design of the UNIX Operating System, PHI, by Maurice J. Bach.
2. Distributed Computing 2nd Edition, Mahajan and Seema Shah, OXford.
3. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjan G Shivaratri.
4. Mobile Computing by Rajkamal, 1st edition, Oxford.
5. Real Time Operating System, Jane W.S. Liu, Pearson.

Reference Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. "Real-Time Systems: Theory and Practice", Rajib Mall, Pearson Education India, 2006.

Course Code	Course Name	Credit
CSDLO5013	**Advanced Algorithm**	**4**

Course Objectives:

1. To provide mathematical approach for Analysis of Algorithms.
2. To teach advanced data structures.
3. To solve complex problems in real life applications.

Course Outcomes: At the end of the course student will be able to

1. Describe analysis techniques for algorithms.
2. Identify appropriate data structure and design techniques for different problems
3. Identify appropriate algorithm to be applied for the various application like geometric modeling, robotics, networking, etc.
4. Appreciate the role of probability and randomization in the analysis of algorithm
5. Analyze various algorithms.
6. Differentiate polynomial and non deterministic polynomial algorithms.

Prerequisites: Data structures, Discrete mathematics and Analysis of Algorithm

Sr. No.	Module	Detailed Content	Hours
1	**Fundamental of Algorithms**	**Introduction-** **Complexity-**complexity of recursive algorithms, finding complexity by tree method, master method, proving technique (contradiction, mathematical induction). **Amortized analysis-** aggregate analysis, accounting analysis, potential analysis dynamic tables	08
2	**Probabilistic Analysis and Randomized Algorithm**	The hiring problem Indicator random variables Randomized algorithms Probabilistic analysis and further uses of indicator random variable	08
3	**Advanced Data Structure**	**Introduction to trees and heap** **Red-Black Trees:** properties of red-black trees , Operations on Red-black trees **Binomial Heaps:** Binomial trees and binomial heaps, Operation on Binomial heaps **Analysis of all above operations**	12
4	**Maximum Flow**	Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08

5	**Computational Geometry**	Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08
6	**NP-Completeness And Approximation Algorithms**	NP-Completeness: NP-Completeness and reducibility, NP-Completeness proofs, NP-Complete problems-The vertex-cover problem, The travelling salesman problem	08

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition.
2. Horowitz, Sahani and Rajsekaran, "Fundamentals of Computer Algorithms", Galgotia.
3. Harsh Bhasin, "Algorithms – Design and Analysis", Oxford, 2015.

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan, " Randomized Algorithm", Cambridge University
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI
3. Vijay V. Vajirani, "Approximation Algorithms",Springer.

Internal Assessment:

Assessment consists of two tests out of which; one (T1) should be compulsory class test (on at least 02 Modules) and the other (T2) is either a class test or assignments on live problems or course project

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Lab Code	Lab Name	Credits
CSL501	**Microprocessor Lab**	**1**

Lab Objective:

1. To emphasize on use of Assembly language program.
2. To prepare students for advanced subjects like embedded system and IOT.

Lab Outcome:

1. Use appropriate instructions to program microprocessor to perform various task
2. Develop the program in assembly/ mixed language for Intel 8086 processor
3. Demonstrate the execution and debugging of assembly/ mixed language program

Description:

A microprocessor is the most important unit within a computer system. It is responsible for processing the unique set of instructions and processes. It is a controlling unit of a computer, capable of performing Arithmetic Logical Unit (ALU) operations and communicating with the other devices connected to it. Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that are part of the microprocessor design. When computer is turned on, the microprocessor gets the first instruction from the basic input/output system that comes with the computer as part of its memory. After that, either the BIOS, or the operating system that BIOS loads into computer memory, or an application program provides instructions to perform.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8bit/16 bit data
2	Code conversion (Hex to BCD, BCD to Hex, ASCII to BCD, BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/ non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Mixed Language program to shift a number for given number of times
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order

9	Mixed Language program to increment, decrement the size of the cursor and also to disable it.
10	Assembly program to find minimum/ maximum no. from a given array.
11	Program for device driver (printer/mouse/keyboard)
12	Program based on 32 bit architecture (e.g. Switching from real mode to protected mode using DPMI driver, 32bit multiplication)
13	Assembly program to find factorial of number using procedure
14	Program and interfacing using 8255/ 8253
15	Program and interfacing of ADC/ DAC/ Stepper motor

Term Work:

Term should consist of at least 10 experiments.
Journal must include –

- At least one experiment with use of macros/ procedures
- At least five experiments with use of DOS, BIOS interrupts
- At least two assignments

At least one experiment on hardware interfacing is desirable
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum marks in term work.

Term Work: 25 marks (Total) = 15 Marks (Experiments) + 5 Marks (Assignments) + 5 Marks (Theory + Practical Attendance)

Oral & Practical exam will be based on the CSL501and CSC501 syllabus.

Lab Code	Lab Name	Credits
CSL 502	**Computer Network Lab**	**1**

Lab Objective:
To practically explore OSI layers and understand the usage of simulation tools.

Lab Outcomes:
On successful completion of course learner will be able to

1. Design and setup networking environment in Linux.
2. Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3. Implement programs using core programming APIs for understanding networking concepts.

Description
The experiments are expected to be performed in Linux environment.

Suggested List of Experiments

Sr. No	Title of Experiments
1.	Setup a network and configure IP addressing, subnetting, masking. (Eg. CISCO Packet Tracer, Student Ed.)
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer.
4.	Perform network discovery using discovery tools (eg. mrtg)
5.	Use Wireshark to understand the operation of TCP/IP layers : ● Ethernet Layer : Frame header, Frame size etc. ● Data Link Layer : MAC address, ARP (IP and MAC address binding) ● Network Layer : IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
6.	CRC/ Hamming code implementation.
7.	Stop and wait protocol/ sliding window (selective repeat / Go back N)
8.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
9.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following:

	● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
10.	Implementation of DVR/ LSR in NS2/(any other simulator)
11.	Socket programming using TCP or UDP
12.	Simulate congestion control (leaky bucket / token bucket).
13.	Perform File Transfer and Access using FTP
14.	Perform Remote login using Telnet server

Term Work:

Laboratory work should be based on above syllabus of suggested list having minimum 10 experiments, covering all layers.

Experiments ---------- (15) Marks
Assignments ---------- (05) Marks
Attendance (Theory + Practical) ---------- (05) Marks
Total ---------- (25) Marks

Oral & Practical exam will be based on the **above and CSC 503 : Computer Network**.

Lab Code	Lab Name	Credits
CSL503	**Database & Information System Lab**	**1**

Lab Outcome: On successful completion of course learner will be able to:

1. Design and draw ER and EER diagram for the real life problem with software tool.
2. Create and update database and tables with different DDL and DML statements.
3. Apply /Add integrity constraints and able to provide security to data.
4. Implement and execute Complex queries.
5. Apply triggers and procedures for specific module/task
6. Handle concurrent transactions and able to access data through front end (using JDBC ODBC connectivity.)

Description:

- The below suggested experiments needs to be performed by a group of **3/4 students.**
- Select any database management system and conduct all experiments based on the same topic.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create and populate database using Data Definition Language (DDL) and DML Commands for you're the specified System.
4	Apply Integrity Constraints for the specified system.
5	Perform Simple queries, string manipulation operations.
6	Nested queries and Complex queries
7	Perform Join operations
8	Views and Triggers
9	Functions , cursor and procedure.
10	Transaction and Concurrency control
11	Mini project- Creating a Two-tier client-server database applications using JDBC

Assignment: Perform Normalization -1NF, 2NF, 3NF

Term Work:

Laboratory work will be based on DBMS syllabus with minimum 10 experiments to be incorporated.
Experiments should be completed by students on the given time duration
Experiments ---------- (10) Marks
Mini Project---------- (10) Marks
Attendance (Theory + Practical) ---------- (05) Marks
Total ---------- (25) Marks

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Database Management System subject for given list of experiments .

Implementation ---------- ----------(15) Marks
Oral ----------(10) Marks
Total ----------(25) Marks

****Oral & Practical exam** will be based on the above and CSC502: 'DBMS' syllabus

Text Books:

1. G. K. Gupta :"Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, " Fundamentals of Database Systems", 5thEdition, PEARSON
4. Peter Rob and Carlos Coronel, " Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

Reference Books :

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
2. PaulrajPonniah, " Introduction to Database Management",Wiley publication
3. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems",TMH
4. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline

Course Code	Course Name	Credits
CSL504	**Web Design Lab**	**2**

Course objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To Create web pages and provide client side validation.
3. To create dynamic web pages using server side scripting.
4. To use MVC framework for web application development.

Course outcomes: On completion of course learner will be able to:

1. Understand the core concepts and features of Web Technology
2. Design static web pages using HTML5 and CSS3
3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery.
4. Evaluate client and server side technologies and create Interactive web pages using PHP , AJAX with database connectivity using MySQL.
5. Understand the basics of XML, DTD and XSL and develop web pages using XML / XSLT.
6. Analyze end user requirements and Create web application using appropriate web technologies and web development framework

Prerequisite: Data Structures, Basics of Programming Languages

Module No.	Unit No.	Topics	Hrs.
1.0		**INTRODUCTION TO WWW**	**2**
	1.1	Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	
	1.2	Overview of HTTP, HTTP request – response — Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)	
2.0		**CLIENT SIDE PROGRAMMING**	**6**
	2.1	**Markup Language (HTML):** Introduction to HTML and HTML5 - Formatting and Fonts –Commenting Code – Anchors – Backgrounds – Images – Hyperlinks	
	2.2	Lists – Tables – Frames - HTML Forms and controls.	
	2.3	**Cascading Style Sheet (CSS):** The need for CSS, Introduction to CSS 3 – Basic syntax and structure ,CSS Properties-Inline Styles – Embedding Style Sheets	
	2.4	Linking External Style Sheets – Backgrounds –Box Model(Introduction , Border Properties, Padding Properties, Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs	
3.0		**INTRODUCTION TO JAVASCRIPT**	**6**
	3.1	Introduction - Core features - Data types and Variables - Operators, Expressions, and Statements, Functions - Objects - Array, Date and Math related Objects	
	3.2	Document Object Model - Event Handling Controlling Windows &	

		Frames and Documents Form handling and validations.	
	3.3	**Advanced JavaScript** - Browser Management and Media Management – Classes – Constructors – Object-Oriented Techniques in JavaScript	
	3.4	Object constructor and Prototyping - Sub classes and Super classes – JSON - jQuery and AJAX., Rich Internet Application with AJAX, JQuery Framework	
4.0		**SERVER SIDE PROGRAMMING**	**8**
	4.1	Introduction - Programming basics - Print/echo - Variables and constants – Strings and Arrays	
	4.2	Operators, Control structures and looping structures – Functions – Reading Data in Web Pages	
	4.3	Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication	
	4.4	AJAX with PHP - AJAX with Databases	
5.0		**XML**	**4**
	5.1	Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML –DTD(Document Type Definition) - XML Schema	
	5.2	XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language	
6.0		**WEB DEVELOPMENT FRAMEWORK**	**2**
	6.1	Introduction to Composer - MVC Architecture	
	6.2	Web Application Development using web development framework :-Introduction to Laravel, Development of Web pages using Laravel., Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.	
		Total	**28**

Text Books:

1. Ralph Moseley , M.T. Savliya ," Developing Web Applications", Willy India, Second Edition, ISBN: 978-81-265-3867-6
2. "Web Technology Black Book", Dremtech Press, First Ediction, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm

Reference Books:

1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web - How To Program", Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and AtulKahate, "Web Technologies", Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.

4. David Flanagan, “JavaScript: The Definitive Guide, Sixth Edition”, O'Reilly Media, 2011
5. Steven Holzner, “The Complete Reference - PHP”, Tata McGraw Hill, 2008
6. Mike Mcgrath, “PHP & MySQL in easy Steps”, Tata McGraw Hill, 2012.

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Term work Assessment:

Term work will consist of lab experiments testing all the technologies included in syllabus and a **Mini project** solving an appropriate problem using the above technology.

Module	Detailed Contents	Lab Sessions
1	Installation and Setting of LAMP / WAMP / XAMP	1
2	Create Simple web page using HTML5	1
3	Design and Implement web page using CSS3 and HTML5	1
4	Form Design and Client Side Validation using : a. Javascript and HTML5 b. Javascript and JQuery	2
5	Develop simple web page using PHP	1
6	Develop interactive web pages using PHP with database connectivity MYSQL	2
7	Develop XML web page using DTD, XSL	1
8	Implement a webpage using Ajax and PHP	1
9	Hosting the website with Domain Registration Process.	1
10	Design a Web application using Laravel Framework	3

*** *Setting up /buying the web host management system for hosting of mini project is recommended.**

Term Work: The distribution of marks for term work shall be as follows:

- Lab Assignments : 10 Marks
- Mini Project : 10 Marks
- Attendance : 05 Marks

Practical & Oral Examination:

Practical & Oral examination is to be conducted by pair of internal and external examiners based on the above syllabus.

Course Code	Course Name	Credits
CSL505	**Business Communication & Ethics**	**02**

Course Objectives:

1. To inculcate professional and ethical attitude at the work place
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving.

Course Outcomes: Learner will be able to…

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education , upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	**Detailed Contents**	**Hrs.**
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports(Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing(IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	

06	**Employment Skills**	**07**
6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

Assessment:

List of Assignments

1. Report Writing(Theory)
2. Technical Proposal
3. Technical Paper Writing(Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills(Group activities and Role plays)
5. Interpersonal Skills(Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation(Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics(Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list. The distribution of marks for term work shall be as follows:

Book Report	**10 marks**
Assignments:	**10 marks**
Project Report Presentation:	**15 marks**
Group Discussion:	**10 marks**
Attendance:	**05 marks**

References:

1. Fred Luthans," Organizational Behavior", Mc GrawHill,
2. Lesiker and Petit," Report Writing for Business ",McGrawHill
3. R. Subramaniam," Professional Ethics" Oxford University Press
4. Huckin and Olsen, "Technical Writing and Professional Communication ",McGraw
5. Raman and Sharma,FundamentalsofTechnicalCommunication,OxfordUniversityPress
6. Hill Wallace and Masters," Personal Development for Life and Work", Thomson Learning.
7. Heta Murphy," *Effective Business Communication* ",McGraw Hill, edition
8. R.C Sharma and Krishna Mohan," *Business Correspondence and Report Writing",*
9. Raman Sharma, "*Communication Skills",* Oxford University Press
10. B N Ghosh," *Managing Soft Skills for Personality Development* ",Tata McGraw Hill
11. Dufrene, Sinha,"*BCOM*", Cengage Learning, 2ndedition
12. Bell. Smith,"ManagementCommunication"WileyIndiaEdition,3rdedition.
13. Dr. K. Alex, "Soft Skills", S Chand and Company
14. Robbins Stephens P., "Organizational Behavior", Pearson Education
15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Complier Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
	Total	**20**	**12**	-	**20**	**6**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Complier Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	125	25	100	750

Course Code	Course Name	Credits
CSC601	**Software Engineering**	**4**

Course objectives:

The main objective of the course is to introduce to the students about the product that is to be engineered and the processes that provides a framework for the engineering methodologies and practices.

1. To provide the knowledge of software engineering discipline.
2. To apply analysis, design and testing principles to software project development.
3. To demonstrate and evaluate real time projects with respect to software engineering principles.

Course outcomes:

On successful completion of course, learners will be able to:

1. Understand and demonstrate basic knowledge in software engineering.
2. Identify requirements, analyze and prepare models.
3. Plan, schedule and track the progress of the projects.
4. Design & develop the software projects.
5. Identify risks, manage the change to assure quality in software projects.
6. Apply testing principles on software project and understand the maintenance concepts.

Prerequisite:

1. Concepts of Object Oriented Programming & Methodology
2. Knowledge of developing applications with front end & back end connectivity.

Course syllabus:

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction To Software Engineering and Process Models**	**08**
	1.1	Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM)	
	1.2	Generic Process Model, **Prescriptive Process Models:** The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model	
2.0		**Requirements Analysis and Modelling**	**08**
	2.1	Requirement Elicitation, Software requirement specification (SRS), Developing Use Cases (UML)	
	2.2	Requirement Model – Scenario-based model, Class-based model, Behavioural model.	
3.0		**Project Scheduling and Tracking**	**08**
	3.1	Management Spectrum, 3Ps (people, product and process)	
	3.2	Process and Project metrics	

	3.3	**Software Project Estimation:** LOC, FP, Empirical Estimation Models - COCOMO II Model, Specialized Estimation Techniques	
	3.4	**Project scheduling:** Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule, Earned Value Analysis	
4.0		**Software Design**	**10**
	4.1	Design Principles, Design Concepts, Effective Modular Design – Cohesion and Coupling	
	4.2	Architectural Design	
	4.3	Component-level design	
	4.4	User Interface Design	
5.0		**Software Risk, Configuration Management & Quality Assurance**	**08**
	5.1	Risk Identification, Risk Assessment, Risk Projection, RMMM	
	5.2	Software Configuration management, SCM repositories, SCM process	
	5.3	Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough	
6.0		**Software Testing and Maintenance**	**10**
	6.1	Strategic Approach to Software Testing, Unit testing, Integration testing Verification, Validation Testing, System Testing	
	6.2	Software Testing Fundamentals, White-Box Testing , Basis Path Testing, Control Structure Testing, Black-Box Testing,	
	6.3	Software maintenance and its types, Software Re-engineering, Reverse Engineering	
		Total	**52**

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 06 questions, each carrying 20 marks.
2. The students need to solve total 04 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Roger Pressman, “Software Engineering: A Practitioner’s Approach",McGraw-Hill Publications 2. Ian Sommerville, “Software Engineering”, Pearson Education (9th edition)
3. Ali Behfrooz and Fredeick J.Hudson, "Software Engineering Fundamentals", Oxford University Press

Reference Books:

1. Ugrasen Suman, “Software Engineering – Concepts and Practices”, Cengage Learning
2. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa
3. Jibitesh Mishra and Ashok Mohanty, “Software Engineering”, Pearson
4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India

Course Code	Course Name	Credits
CSC602	**System Programming And Compiler Construction**	**4**

Course objectives:

1. To understand the role and functioning of various system programs over application program.
2. To understand basic concepts and designing of assembler, Macro processor and role of static and dynamic loaders and linkers.
3. To understand the need to follow the syntax in writing an application program and to learn the how the analysis phase of compiler is designed to understand the programmer's requirements without ambiguity.
4. To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time.

Course outcomes: On successful completion of course learner will be able to:

1. Identify the relevance of different system programs.
2. Describe the various data structures and passes of assembler design.
3. Identify the need for different features and designing of macros.
4. Distinguish different loaders and linkers and their contribution in developing efficient user applications.
5. Construct different parsers for given context free grammars.
6. Justify the need synthesis phase to produce object code optimized in terms of high execution speed and less memory usage

Prerequisite: Data Structures, Theoretical computer science, Operating system. Computer Organization and Architecture, Microprocessor

Module No.	Unit No.	Topics	Hrs.
1	**Introduction to System Software**	Concept of System Software, Goals of system softwares, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	**2**
2	**Assemblers**	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for Hypothetical / X86 family processor, data structures used.	**10**
3	**Macros and Macro Processor**	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of single pass macro processor, data structures used.	**8**
4	**Loaders and Linkers**	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.	**8**

5	**Compilers: Analysis Phase**	Introduction to compilers, Phases of compilers: Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyser, data structures used . Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- Operator precedence parser, SLR Semantic Analysis, Syntax directed definitions.	**12**
6	**Compilers: Synthesis phase**	Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, Three address codes: Triples and Quadruples. Code Optimization: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. Code Generation: Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	**12**

Text Books:

1. D. M Dhamdhere: Systems programming, Tata McGraw Hill
2. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman : Compilers Principles, Techniques and Tools , Pearson Education , Second Edition.
3. J. J. Donovan: Systems Programming Tata McGraw Hill Publishing Company

Reference Books:

1. Lex &yacc, 2nd Edition by John R. Levine, Tony Mason & Doug Brown O'Reilly
2. Compiler construction D,M.Dhamdhere second edition MACMILLAM.
3. Compiler construction : principles and practices , Kenneth C.Louden ,CENGAGE Learning
4. System software : An introduction to system programming , Leland L. Beck, Pearson

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC603	Data Warehousing and Mining	4

Course objectives:

1. To identify the scope and essentiality of Data Warehousing and Mining.
2. To analyze data, choose relevant models and algorithms for respective applications.
3. To study spatial and web data mining.
4. To develop research interest towards advances in data mining.

Course outcomes: On successful completion of course learner will be able to:

1. Understand Data Warehouse fundamentals, Data Mining Principles
2. Design data warehouse with dimensional modelling and apply OLAP operations.
3. Identify appropriate data mining algorithms to solve real world problems
4. Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5. Describe complex data types with respect to spatial and web mining.
6. Benefit the user experiences towards research and innovation.

Prerequisite: Basic database concepts, Concepts of algorithm design and analysis.

Module No.	Topics	Hrs.
1.0	**Introduction to Data Warehouse and Dimensional modelling:** Introduction to Strategic Information, Need for Strategic Information, Features of Data Warehouse, Data warehouses versus Data Marts, Top-down versus Bottom-up approach. Data warehouse architecture, metadata, E-R modelling versus Dimensional Modelling, Information Package Diagram, STAR schema, STAR schema keys, Snowflake Schema, Fact Constellation Schema, Factless Fact tables, Update to the dimension tables, Aggregate fact tables.	8
2.0	**ETL Process and OLAP:** Major steps in ETL process, Data extraction: Techniques, Data transformation: Basic tasks, Major transformation types, Data Loading: Applying Data, OLTP Vs OLAP, OLAP definition, Dimensional Analysis, Hypercubes, OLAP operations: Drill down, Roll up, Slice, Dice and Rotation, OLAP models : MOLAP, ROLAP.	8
3.0	**Introduction to Data Mining, Data Exploration and Preprocessing:** Data Mining Task Primitives, Architecture, Techniques, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration :Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Cleaning, Integration, Reduction: Attribute subset selection, Histograms, Clustering and Sampling, Data Transformation & Data Discretization: Normalization, Binning, Concept hierarchy generation, Concept Description: Attribute oriented Induction for Data Characterization.	10

4.0	**Classification, Prediction and Clustering:** Basic Concepts, Decision Tree using Information Gain, Induction: Attribute Selection Measures, Tree pruning, Bayesian Classification: Naive Bayes, Classifier Rule - Based Classification: Using IF-THEN Rules for classification, Prediction: Simple linear regression, Multiple linear regression Model Evaluation & Selection: Accuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap, Clustering: Distance Measures, Partitioning Methods (*k*-Means, *k*-Medoids), Hierarchical Methods(Agglomerative, Divisive)	**12**
5.0	**Mining Frequent Patterns and Association Rules:** Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, FP growth, Mining frequent Itemsets using Vertical Data Format, Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules	**8**
6.0	**Spatial and Web Mining:** Spatial Data, Spatial Vs. Classical Data Mining, Spatial Data Structures, Mining Spatial Association and Co-location Patterns, Spatial Clustering Techniques: CLARANS Extension, Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining, Applications of Web Mining	**6**
	Total	**52**

Text Books:

1. PaulrajPonniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd edition.
3. ReemaTheraja “Data warehousing”, Oxford University Press.
4. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Reference Books:

1. Ian H. Witten, Eibe Frank and Mark A. Hall " Data Mining ", 3rd Edition Morgan kaufmann publisher.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.
3. R. Chattamvelli, "Data Mining Methods" 2nd Edition NarosaPublishing House.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC604	Cryptography and System Security	4

Course Objectives:

1. To introduce classical encryption techniques and concepts of modular arithmetic and number theory.
2. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3. To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
4. To develop the ability to use existing cryptographic utilities to build programs for secure communication.

Course Outcomes: At the end of the course learner will able to

1. Understand system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory.
2. Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes.
4. Apply different digital signature algorithms to achieve authentication and design secure applications
5. Understand network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.
6. Analyze and apply system security concept to recognize malicious code.

Detailed Syllabus:

Module No	Unit No	Detailed Content	Hrs
1	**Introduction & Number Theory**		10
	1.1	Security Goals, Services, Mechanisms and attacks, The OSI security architecture, Network security model, Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography.	
	1.2	Modular Arithmetic and Number Theory:- Euclid's algorithm–Prime numbers-Fermat's and Euler's theorem- Testing for primality -The Chinese remainder theorem, Discrete logarithms.	
2	**Symmetric and Asymmetric key Cryptography and key Management**		12

	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC5 algorithm.	
	2.2	Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, ElGamal Algorithm.	
	2.3	Key management techniques: using symmetric and asymmetric algorithms and trusted third party. Diffie Hellman Key exchange algorithm.	
3	**Hashes, Message Digests and Digital Certificates**		06
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.	
	3.2	Digital Certificate: X.509, PKI	
4	**Authentication Protocols & Digital signature schemes**		08
	4.1	User Authentication and Entity Authentication, One-way and mutual authentication schemes, Needham Schroeder Authentication protocol, Kerberos Authentication protocol.	
	4.2	Digital Signature Schemes – RSA, EIGamal and Schnorr signature schemes.	
5	**Network Security and Applications**		10
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing.	
	5.2	Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service, Defenses against Denial of Service Attacks.	
	5.3	Internet Security Protocols: SSL, IPSEC, Secure Email: PGP, Firewalls, IDS and types, Honey pots	
6	**System Security**		06
	6.1	Software Vulnerabilities: Buffer Overflow, Format string, cross-site scripting, SQL injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.	

Text Books:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013
2. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill
3. Bernard Menezes, "Cryptography & Network Security", Cengage Learning.
4. Network Security Bible, Eric Cole, Second Edition, Wiley.

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSDLO6021	**Machine Learning**	**04**

Course Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, classification methods, clustering methods.
3. To become familiar with Dimensionality reduction Techniques.

Course Outcomes: Students will be able to-

1. Gain knowledge about basic concepts of Machine Learning
2. Identify machine learning techniques suitable for a given problem
3. Solve the problems using various machine learning techniques
4. Apply Dimensionality reduction techniques.
5. Design application using machine learning techniques

Pre-requisites: Data Structures, Basic Probability and Statistics, Algorithms

Module No.	Unit No.	Topics	Hrs.
1		**Introduction to Machine Learning** Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	**6**
2		**Introduction to Neural Network** Introduction – Fundamental concept – Evolution of Neural Networks – Biological Neuron, Artificial Neural Networks, NN architecture, Activation functions, McCulloch-Pitts Model.	**8**
3		**Introduction to Optimization Techniques:** Derivative based optimization- Steepest Descent, Newton method. Derivative free optimization- Random Search, Down Hill Simplex	**6**
4		**Learning with Regression and trees:** Learning with Regression : Linear Regression, Logistic Regression. Learning with Trees**:** Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART).	**10**
5		**Learning with Classification and clustering:**	**14**
	5.1	**Classification:** Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. **Support Vector Machine**: Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	
	5.2	**Clustering:** Expectation Maximization Algorithm, Supervised learning	

		after clustering, Radial Basis functions.	
6		**Dimensionality Reduction:** Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Single value decomposition	**8**
		Total	**52**

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. Samir Roy and Chakraborty, “Introduction to soft computing”, Pearson Edition.
7. Kevin P. Murphy , Machine Learning “ A Probabilistic Perspective”

Reference Books:

1. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
2. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested Experiment work :

1. To implement Linear Regression.
2. To implement Logistic Regression.
3. To implement SVM.
4. To implement PCA.
5. To implement Steepest Descent
6. To implement Random search
7. To implement Naïve Baysian algorithm.
8. To implement Single layer Perceptron Learning algorithm
9. To implement Radialbasis functions.
10. Case study based on any ML technique

**** Laboratory work based on above syllabus is incorporate as mini project in CSM605: Mini-Project.**

Course Code	Course Name	Credits
CSDLO6022	Advanced Database Management System	4

Course objectives:

1. To provide overview of indexing and hashing techniques
2. To impart knowledge of query processing and optimization
3. To provide an overview of distributed database systems.
4. To introduce the concept of document oriented database.
5. To create awareness about potential security threats to a database and mechanisms to handle it.
6. Understand the usage of advanced data models for real life application.

Course outcomes: On successful completion of course learner will be able to:

1. Build indexing mechanisms for efficient retrieval of information from databases.
2. Measure query cost and optimize query execution
3. Design distributed database for better resource management
4. Demonstrate the understanding of the concepts of document oriented databases.
5. Apply appropriate security techniques database systems.
6. Implement advanced data models for real life applications.

Prerequisite: Basic knowledge of Database management System.

Module No.	Unit No.	Topics	Hrs.
1.0		**Indexing and Hashing Techniques**	8
	1.1	**Indexing and Hashing:** ● Operation on Files ● Hashing Techniques; Static and dynamic ● Types of Single-Level Ordered Indexes; Multilevel Indexes; Dynamic Multilevel Indexes Using B-Trees and B+-Trees; Indexes on Multiple Keys,	
2.0		**Query processing and Optimization**	12
		Query Processing : ● Overview ● Measures of Query cost ● Selection operation ● Sorting ● Join Operations, and other Operations Evaluation of Expression **Query Optimization :** ● Translations of SQL Queries into relational algebra ● Heuristic approach & cost based optimization	

3.0		**Distributed Databases**	12
	3.1	• Types of Distributed Database Systems; Distributed Database Architectures; Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design	
	3.2	• Distributed Query Processing (Semi join) • distributed Transaction Management in Distributed Databases • distributed Concurrency Control (locking) , Recovery in Distributed Databases {2PC/3PC) and deadlock management.	
4		**Document oriented database**	
		• Need of object oriented database. • Impedance matching problem between OO languages and Relational database, Case study db4O • Need of Document Oriented database, difference between Document Oriented Database and Traditional database. Types of encoding XML, JSON, BSON, Representation XML, Json Objects. Case study on doc oriented based such a Mariadb	8
5		**Advanced data models**	6
	5.1	• Temporal data models :- Aspects of valid time , Bi-temporal time and bi-temporal time with examples of each. • Spatial model :- Types of spatial data models - Raster, Vector and Image • Mobile databases	
	5.2	• Multimedia databases	
6		**Data Security**	**6**
	6.1	• Introduction to Database Security Issues; authorization , Discretionary Access Control Based on Granting and Revoking Privileges • Mandatory Access Control and Role-Based	

	6.2	Access Control for Multilevel Security ● SQL Injection ● Introduction to Statistical Database Security Introduction to Flow Control	
		Total	**52**

Text Books:

1. Elmasri&Navathe“ fundamentals of Database Systems” IV edition. PEARSON Education.
2. Korth, Silberschatzsudarshan “Database systems, concepts” 5th edition McGraw Hill
3. Raghu Ramkrishnan& Johannes Gehrke “Database Management System” Tata McGraw Hill. III edition.
4. Ruosell J.T. Dyer, Learning MySQL and Mariadb.

Reference Books:

1. Chhanda Ray , “Distributed Database System”, Pearson Education India.
2. Hector Garcia-Molina, Jeffery D. Ullman, Jennifer Widom , “ Database system Implementation”
3. Thomas M.Connolly Carolyn Begg, Database Systems : A practical Approach to Design , Implementation and Management, 4/e.

Suggested mini. Project / Experiment work:

1. Given problem statement 2/3 student to perform-
   a. Design EER model and perform sorting, join operations for the specified problem statement.
   b. Perform the various fragmentation (Horizontal, Vertical, Derived) and check its correctness criteria.
   c. Perform two phase commit protocol (2PC)
2. Mini Project / Case study on document oriented database such a Mariadb
3. Mini Project Case study Development of an application based on any one advance data model (temporal, Spatial Multimedia)

**** Perform Laboratory (Experiments) work in the in CSM605:Mini-Project**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6023	**Enterprise Resource Planning(ERP)**	**4**

Course Objectives:

1. To understand the technical aspects and life cycle of ERP systems.
2. To understand the steps and activities in ERP.
3. To identify and describe different types of ERP system.
4. To understand tools and methodology used for designing ERP for an Enterprise.

Course Outcomes: After completion of this course, students will be able ..

1. To understand the basic structure of ERP.
2. To identify implementation strategy used for ERP.
3. To apply design principles for various business modules in ERP.
4. To apply different emerging technologies for implementation of ERP.
5. To analyze security issues in ERP.
6. To acquire ERP concepts for real world applications.

Pre-requisites: Web Engineering, Computer Network, Database Systems

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Enterprise Resource Planning (ERP)** Information System and Its Components, Value Chain Framework, Organizational Functional Units, Evolution of ERP Systems, Role of ERP in Organization, Three-Tier Architecture of ERP system.	**8**
2.0		**ERP and Implementation** ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition, implementation Methodology.	**8**
3.0		**ERP Business Modules**	**8**
	3.1	Finance, manufacturing, human resources, quality management, material management, marketing, Sales distribution and service.	
	3.2	Case study on Supply Chain management (SCM), Customer relationship Management (CRM)	
4.0		**Introduction to ERP related Technologies**	**10**
	4.1	Business Process Re-engineering (BPR) ,Data warehousing ,Data Mining, On- line Analytical Processing(OLAP), Product Life Cycle Management (PLM)	
	4.2	Geographical Information Management ,RFID, QR Code ,Bar	

		Coding, E-commerce and their application in Enterprise planning	
5.0		Extended ERP and security issues	**8**
	5.1	Enterprise application Integration (EAI), open source ERP, cloud ERP	
	5.2	Managing ERP Securities: Types of ERP security Issues, System Access security, Data Security and related technology for managing data security	
6.0		Cases of ERP for Enterprises.	**10**
	6.1	Cases of ERP like MySAP for Business suite implementation at ITC, ERP for Nestle GLOBE Project, Oracle ERP Implementation at Maruti Suzuki.	
	6.2	Need of ERP for Small and Medium size enterprises.(Zaveri)	
		Total	**52**

Text Books:

1. Alexis Leon, ERP Demystified: II Edition, Tata McGraw Hill.
2. Rajesh Ray, Enterprise Resource Planning, Text and cases, Tata McGraw Hill.
3. Sandeep Desai, Abhishek Srivastava, ERP to E^2 ERP: A Case study approach, PHI.
4. Jyotindra Zaveri, Enterprise Resource Planning, Himalaya Publishing House, 2012.

Reference Books:

1. V.K. Garg & N.K. Venkatakrishnan, Enterprise Resource Planning: concepts & practices, by ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. Enterprise wide resource planning: Theory & practice: by Rahul Altekar, PHI
4. Customer Relationship Management, Concepts and cases, Second Edition.

Mini Project / Laboratory Work:

1. Give case study 2/3 student of any organization. Make a report before-after situation at organization (Domain).
2. Make a list of Resource of the Selected Domain.
3. Categorized the Resource as per the function level process and Identify module of the domain.
4. Explain process of each module of the domain.
5. Perform Business process re-engineering (BPR) on selected Module.
6. Implement new system based on BPR.
7. Perform Impact analysis of the new system as the BPR.
    a. Prepare study on JD Edward Tool.

b. Prepare study on Microsoft Dynamics.

8. Download any open source ERP Tool and prepare Installation Guideline and information about the Tool.
9. Make Data Entry in the Software in all modules & generate report.

**** Perform Laboratory (Experiments) work in the in CSM605:Mini-Project.**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.

- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6024	**Advanced Computer Network**	**4**

Course Objective:

1. To make learners aware about advances in computer networking technologies.
2. To give overview of advance internet, QoS based and management protocols.
3. To introduce issues related to traffic engineering and capacity planning.

Course Outcomes: On successful completion of course learner will be able to

1. Demonstrate the understanding of advance data communication technologies.
2. Demonstrate the understanding of WAN Technology typically ATM .
3. Demonstrate the understanding of packet switching protocols such as X.25, X.75.
4. Explore the issues of advance internet routing protocols and also QoS based protocols.
5. Analyze issues of traffic requirements and perform capacity planning.
6. Demonstrate the understanding of protocol used for management of network.

Prerequisite: Computer Networks, ISO OSI Layered Protocols, TCP/IP protocol suite.

Module No.	**Unit No.**	**Topics**	**Hrs.**
1	**Data Communications:**		**06**
	1.1	Defining Data Communication needs, Transmission Hierarchy	
	1.2	**Optical Networks**: SONET/SDH standard, Architecture, Format, Hardware, Configuration, advantages	
2	**WAN Technology:**		**10**
	2.1	Introducing ATM Technology, Need and Benefit, Concept, Faces of ATM	
	2.2	Why ATM, BISDN Reference Model, ATM Layer, ATM Adaptation Layer, ATM Signaling	
3	**Protocols and Interfaces:**		**10**
	3.1	**Introduction to TCP/IP:** Issues in IPV4, IPV6 protocol	
	3.2	**Mature Packet Switching Protocols:** ITU Recommendation X.25, User Connectivity, Theory of Operations, Network Layer Functions, X.75 Internetworking Protocol, Advantages and Drawbacks	

4	**Advance Routing Protocols:**		**14**
	4.1	**Internet Routing Protocols :** OSPF, RIP, BGP **Multicast Routing:** Reverse Path Broadcasting, Internet Group Management Protocol, Reverse Path Multicasting, Discrete Vector Multicasting protocol	
	4.2	IP forwarding Architectures **Overlay Model:** Classical IP over ATM and LANE	
	4.3	**Multiprotocol Label Switching MPLS :** Fundamentals of Labels, Label Stack, VC Merging, Label Distribution Protocol, Explicit routing for Traffic Engineering	
	4.4	Integrated services, RSVP, Differentiated Services	
	4.5	**MultiMedia Over Internet:** RTP, Session Control Protocol H.323	
5	**Traffic Engineering :**		**08**
	5.1	**Requirement Definition:** User requirement Traffic Sizing , Traffic Characteristics, Protocols, Time and Delay Considerations	
	5.2	**Traffic Engineering and Capacity planning:**Throughput calculation, Traffic Engineering basics, Traditional traffic Engineering and Queued data and Packet Switched packet modeling, Queuing Disciplines (M/M/1), Design parameters for Peak: delay or latency, availability and reliability.	
6	**Network management**		**04**
	6.1	**Network Management :** SNMP Concept and format, Management Components: SMI, MIB	

Text Books:

1. M. A. Gallo and W. M. Hancock, Computer Communications and Networking Technologies, Cengage Learning, (1e).
2. Leon-Garcia, Communication Networks, Tata McGraw-Hill.
3. Darren L. Spohn, Data Network Design, Tata McGraw-Hill.
4. BehrouzForouzan, TCP/IP Protocol Suite ,McGraw-Hill, (5e).
5. William Stallings, High-Speed Networks and Internets, Pearson Education, (2e).

Reference Books:

1. Andrew Tanenbaum“ Computer Networks”, Prentice Hall, (5e).
2. Cisco Certified Network Analyst study guide, Wiley Publishing House.(7e).
3. Douglas E. Comer, Internetworking with TCP/IP Volume One, (6e).
4. James F. Kurose, Keith W. Ross, “Computer Networking, A Top-Down Approach Featuring the Internet”,Addison Wesley, (5e).

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credits
CSL601	**Software Engineering Lab**	**1**

Lab Outcome:

On successful completion of laboratory sessions, learners will be able to

1. Identify requirements and apply process model to selected case study.
2. Analyze and design models for the selected case study using UML modeling.
3. Use various software engineering tools.

Description:

The Software Engineering Lab has been developed by keeping in mind the following objectives:

- Select case studies to solve real life problems by applying software engineering principles.
- To impart state-of-the-art knowledge on Software Engineering and UML.

List of Experiments:

Laboratory work will be based on course syllabus with minimum 10 experiments to be incorporated. Assign case study to a group of two/three students and each group to perform the following experiments on their case study.

Sr. No.	Title of Experiments
1	Prepare detailed statement of problem for the selected / allotted mini project and identify suitable process model for the same with justification.
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project.
3	Use project management tool to prepare schedule for the project.
4	Prepare RMMM plan for the project.
5	Identify scenarios & develop UML Use case and Class Diagram for the project.
6	Draw DFD (upto 2 levels) and prepare Data Dictionary for the project.
7	Develop Activity / State Transition diagram for the project.
8	Develop Sequence and Collaboration diagram for the project.
9	Change specification and make different versions using any SCM Tool.
10	Develop test cases for the project using white box testing.

Digital Material:

Practical can be conducted using any open source software tools like Dia, Star UML, etc.

Term Work:

Term work (25 Marks) shall consist of

- Laboratory work ….. 15 marks
- Two assignments … 05 marks
- Attendance (theory and practical) ….. 05 marks

Oral exam will be based on CSC601 and CSL601 syllabus.

Lab Code	Lab Name	Credits
CSL602	**System Software Lab**	**1**

Outcome: At the end of the course learner will be able to

1. Generate machine code by using various databases generated in pass one of two pass assembler.
2. Construct different databases of single pass macro processor.
3. Identify and validate different tokens for given high level language code.
4. Parse the given input string by constructing Top down /Bottom up parser.
5. Implement synthesis phase of compiler with code optimization techniques.
6. Explore various tools like LEX and YACC.

Description: The current System Software is highly complex with huge built in functionality offered to the programmer to develop complex applications with ease. This laboratory course aims to make a student understand-

- The need for modular design
- The need for well-defined data structures and their storage management
- The increase in the complexity of translators as we move from assembly level to high level programming
- The need to produce an efficient machine code that is optimized for both execution speed and memory requirement
- The efficient programming constructs that make them a good coder

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Implementations of two pass Assembler.
2	Implementation of single pass Macro Processor.
4	Implementation of Lexical Analyzer.
5	Implementation of Parser (Any one).
6	Implementation of Intermediate code generation phase of compiler.
7	Implementation of code generation phase of compiler.
8	Study and implement experiments on LEX. YACC, Grey Box Probing.

Reference Books:

1. Modern Compiler. Implementation in Java, Second. Edition. Andrew W. Appel Princeton University. Jens Palsberg Purdue University. CAMBRIDGE.
2. Crafting a compiler with C**,** Charles N. Fischer, Ron K. Cytron, Richard J. LeBlanc .

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/case studies): ……..(15) Marks.
- Assignment: ...……..……... (05) Marks.
- Attendance ……..…… (05) Marks

  TOTAL: …….. (25) Marks.

Oral & Practical exam will be based on the above and **CSC602** syllabus.

Lab Code	Lab Name	Credits
CSL603	**Data Warehousing and Mining Lab**	**1**

Lab Outcome:

1. Design data warehouse and perform various OLAP operations.
2. Implement classification, prediction, clustering and association rule mining algorithms.
3. Demonstrate classifications, prediction, clustering and association rule mining algorithms on a given set of data sample using data mining tools.
4. Implement spatial and web mining algorithms.

Description:

An operational database undergoes frequent changes on a daily basis on account of the transactions that take place. A data warehouses provides us generalized and consolidated data in multidimensional view. Data mining functions such as classification, prediction, clustering, and association rule mining can be integrated with OLAP operations to enhance the interactive mining of knowledge at multiple level of abstraction. Data mining supports knowledge discovery by finding hidden patterns and associations, constructing analytical models, performing classification and prediction, these mining results can be demonstrated using the data mining tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Build Data Warehouse/Data Mart for a given problem statement i) Identifying the source tables and populating sample data ii) Design dimensional data model i.e. Star schema, Snowflake schema and Fact Constellation schema (if applicable)
2	To perform various OLAP operations such as slice, dice, drilldown, rollup, pivot
3	Implementation of Classification algorithm(Decision Tree/ Bayesian)
4	Implementation of Linear Regression.
5	Implementation of Clustering algorithm(K-means/ Agglomerative).
6	Implementation of Association Rule Mining algorithm(Apriori).

7	Perform data Pre-processing task and Demonstrate performing Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA,R tool, XL Miner, etc.)
8	Implementation of page rank algorithm.
9	Implementation of HITS algorithm.
10	Implementation of Spatial Clustering Algorithm- CLARANS Extensions

Term Work:

Laboratory work will be based on above syllabus with minimum 08 experiments to be incorporated.

Experiments ---------- (15) Marks
Assignment---------- (05) Marks
Attendance (Theory + Practical) ---------- (05) Marks
Total ---------- (25) Marks

Oral & Practical exam will be based on the above and CSC603:"Data Warehousing and Mining" syllabus.

Lab Code	Lab Name	Credit
CSL604	**System Security Lab**	**01**

Lab Outcome:

Learner will able to

1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers.
2. To be able to analyze and implement public key algorithms like RSA and El Gamal.
3. To analyze and evaluate performance of hashing algorithms.
4. To explore the different network reconnaissance tools to gather information about networks.
5. To explore and use tools like sniffers, port scanners and other related tools for analysing packets in a network.
6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.
7. To be able to explore various attacks like buffer-overflow, and web-application attacks.

Suggested Experiment List: (Any 10)

Sr. No	Description
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers
2	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools : wireshark, : 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools.
10	Simulate buffer overflow attack using Ollydbg, Splint, Cppcheck etc

11	a. Set up IPSEC under LINUX. b. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security
14	SQL injection attack, Cross-Cite Scripting attack simulation

Reference Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, TIm Boyles, Sybex.
3. Network Security Bible, Eric Cole, Wiley India.
4. Web Application Hacker's Handbook, Dafydd Stuttard, Marcus Pinto, Wiley India.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Experiments ---------- (15) Marks
Assignment---------- (05) Marks
Attendance (Theory + Practical) ---------- (05) Marks
Total ---------- (25) Marks

Oral & practical examination will be based on the above and Cryptography and System Security (CSC604) syllabus.

Lab Code	Lab Name	Credit
CSM605	**Mini-Project**	**2**

Lab Outcome: After successful completion of this Lab student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
3. Contribute as an individual or in a team in development of technical projects
4. Develop effective communication skills for presentation of project related activities

Description:

Mini project may be carried out in one or more form of following:

Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software and hardware, statistical data analysis, creating awareness in society, etc.

Guidelines:

- A project to be developed based on one or more of the following fields-
  Advance Database Management System, Enterprise Resource Planning, Advance Operating System, Advance Computer Network, etc.
- Mini project may be carried out a group of 2 /3 students. The student is required to submit a report based on the work. The evaluation of the project shall be on continuous basis.

Term Work (TW):

Distribution of marks for term work shall be as follows:

1. Attendance 05 Marks
2. Mini project work 10 Marks
3. Project Report (Spiral Bound) 10 Marks

The final certification and acceptance of TW ensures the satisfactory performance on the above three aspects.

Oral & Practical Examination should be conducted by internal and external examiners appointed by University of Mumbai. Students have to give presentation and demonstration on the Mini-Project.

AC –

Item No.

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

B. E. Computer Engineering (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC701	Digital Signal & Image Processing	4	-	-	4	-	-	4
CSC702	Mobile Communication & Computing	4	-	-	4	-	-	4
CSC703	Artificial Intelligence & Soft Computing	4	-	-	4	-	-	4
CSDLO 701X	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course-I	3	-	-	3	-	-	3
CSL701	Digital Signal & Image Processing Lab	-	2	-	-	1	-	1
CSL702	Mobile App. Development. Tech. Lab	-	2	-	-	1	-	1
CSL703	Artificial Intelligence & Soft Computing Lab	-	2	-		1	-	1
CSL704	Computational Lab-I	-	2			1	-	1
CSP705	Major Project-I	-	6			3	-	3
	Total	**19**	**14**	-	**19**	**7**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC701	Digital Signal & Image Processing	20	20	20	80	3	-	--	-	100
CSC702	Mobile Communication & Computing	20	20	20	80	3	-	--	-	100
CSC703	Artificial Intelligence & Soft Computing	20	20	20	80	3	-	--	-	100
CSDLO 701X	Department Level Optional Course -III	20	20	20	80	3	-	--	-	100
ILO701X	Institute Level Optional Course-I	20	20	20	80	3	--	--	-	100
CSL701	Digital Signal & Image Processing Lab	-	-	-	-	-	25	--	--	25
CSL702	Mobile App. Development. Tech. Lab	-	-	-	-	-	25	--	25	50
CSL703	Artificial Intelligence & Soft Computing Lab	--	-	-	-	--	25	25	--	50
CSL704	Computational Lab-I						25	--	25	50
CSP705	Major Project-I	-	-	-	-	-	50	-	25	75
Total		100	100	100	400		150	25	75	750

Sem.	Department Level Optional Course (DLOC)	Institute Level Optional Course (ILOC)
V	CSDLO5011: Multimedia System CSDLO5012: Advance Operating System CSDLO5013: Advance Algorithm	----------
VI	CSDLO6021: Machine Learning CSDLO6022: Advance Database System CSDLO6023: Enterprise Resource Planning CSDLO6024: Advance Computer Network	----------
VII	CSDLO7031: Advance System Security & Digital Forensics CSDLO7032: Big Data & Analytics CSDLO7033: Robotics	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering
VIII	DLO8011: High Performance Computing DLO8012: Natural Language Processing DLO8013: Adhoc Wireless Network	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Name	Credits
CSC701	Digital Signal & Image Processing	4

Course objectives:

1. To understand the fundamental concepts of digital signal processing and Image processing.
2. To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3. To apply processing techniques on 1-D and Image signals.
4. To apply digital image processing techniques for edge detection.

Course outcomes: On successful completion of the course learner will be able to:

1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyze discrete time signals and systems
3. Implement Digital Signal Transform techniques DFT and FFT.
4. Use the enhancement techniques for digital Image Processing
5. Differentiate between the advantages and disadvantages of different edge detection techniques
6. Develop small projects of 1-D and 2-D Digital Signal Processing.

Prerequisite: Applied Mathematics

Module No.	Unit No.	Topic details	Hrs.
1.0		**Discrete-Time Signal and Discrete-Time System**	14
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations(shifting, reversal, scaling, addition, multiplication).	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems	
	1.3	Linear Convolution formulation for 1-D and 2-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, LTI system, Concept of Impulse Response and Step Response, Output of DT system using Time Domain Linear Convolution.	
2.0		**Discrete Fourier Transform**	08
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT	
	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties.	
	2.3	Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT	
3.0		**Fast Fourier Transform**	06
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm,	

Module No.	Unit No.	Topic details	Hrs.
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm.	
	3.3	Spectral Analysis using FFT	
4.0		**Digital Image Fundamentals**	**08**
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization	
	4.2	Representation of Digital Image, Connectivity	
	4.3	Image File Formats: BMP, TIFF and JPEG.	
5.0		**Image Enhancement in Spatial domain**	**10**
	5.1	Gray Level Transformations, Zero Memory Point Operations,	
	5.2	Histogram Processing, Histogram equalization.	
	5.3	NeighborhoodProcessing, Spatial Filtering, Smoothing and Sharpening Filters, Median Filter.	
6.0		**Image Segmentation**	**06**
	6.1	Segmentation based on Discontinuities (point, Line, Edge),	
	6.2	Image Edge detection using Robert, Sobel, Previtt masks, Image Edge detection using Laplacian Mask.	
		Total	**52**

Text Books:

1. John G. Proakis, Dimitris and G.Manolakis, 'Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, 'Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009,
4. S. Sridhar, 'Digital Image Processing', Oxford University Press, Second Edition, 2012.

Reference Books:

1. Sanjit Mitra, 'Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
2. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, 'Digital Signal Processing' Tata McGraw Hill Publication 1st Edition (2010).
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, 'Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
4. Anil K. Jain, 'Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 50% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC702	**Mobile Communication & Computing**	**4**

Course objectives:

1. To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications.
2. To explore both theoretical and practical issues of mobile computing.
3. To provide an opportunity for students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.

Course outcomes: On successful completion of course learner will be able:

1. To identify basic concepts and principles in mobile communication & computing, cellular architecture.
2. To describe the components and functioning of mobile networking.
3. To classify variety of security techniques in mobile network.
4. To apply the concepts of WLAN for local as well as remote applications.
5. To describe and apply the concepts of mobility management
6. To describe Long Term Evolution (LTE) architecture and its interfaces.

Prerequisite: Computer Networks

Module No.	Unit No.	Topics	Hrs
1.0	1.1	Introduction to Mobile Computing, Telecommunication Generations, Cellular systems,	06
	1.2	Electromagnetic Spectrum, Antenna ,Signal Propagation, Signal Characteristics, , Multiplexing, Spread Spectrum: DSSS & FHSS	
2.0	2.1	GSM Mobile services, System Architecture, Radio interface, Protocols , Localization and Calling, Handover, security (A3,A5 & A8)	**10**
	2.2	GPRS system and protocol architecture	
	2.2	UTRAN , UMTS core network ; Improvements on Core Network,	
3.0	**3.1**	**Mobile Networking** : Medium Access Protocol, Internet Protocol and Transport layer	**12**
	3.2	Medium Access Control: Motivation for specialized MAC, , Introduction to multiple Access techniques (MACA)	

	3.3	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Reverse Tunneling, Routing (DSDV,DSR)	
	3.4	Mobile TCP : Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission	
4.0	**4.1**	**Wireless Local Area Networks :** Introduction, Infrastructure and ad-hoc network	**08**
	4.2	**IEEE 802.11:**System architecture , Protocol architecture , Physical layer, Medium access control layer, MAC management, 802.11a, 802.11b	
	4.3	Wi-Fi security : WEP ,WPA, Wireless LAN Threats , Securing Wireless Networks	
	4.4	HiperLAN 1 & HiperLAN 2	
	4.5	Bluetooth: Introduction, User Scenario, Architecture, protocol stack	
5.0	**5.1**	**Mobility Management :** Introduction, IP Mobility, Optimization, IPv6	06
	5.2	Macro Mobility : MIPv6, FMIPv6,	
	5.3	Micro Mobility: CellularIP, HAWAII, HMIPv6,	
6.0	**6.1**	**Long-Term Evolution (LTE) of 3GPP :** LTE System Overview, Evolution from UMTS to LTE	10
	6.2	LTE/SAE Requirements, SAE Architecture	
	6.3	EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to LTE-Advanced,	
	6.4	System Aspects, LTE Higher Protocol Layers, LTE MAC layer, LTE PHY Layer,	
	6.5	Self Organizing Network (SON-LTE),SON for Heterogeneous Networks (HetNet), Introduction to 5G	
		Total	**52**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1 Jochen Schilller,"Mobile Communication ", Addision wisely,Pearson Education
2 "Wireless Communications & Networks," By William Stallings, Second Edition, Pearson Education
3 Raj Kamal, Mobile Computing, 2/e , Oxford University Press-New Delhi

Reference Books:

1 LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency, Seppo Hamalainen, Henning Sanneck , Cinzia Sartori, Wiley publications
2 Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications," Wiley publications
3 Mobility Protocols and Handover Optimization: Design, Evaluation and Application By Ashutosh Dutta, Henning Schulzrinne, IEEE Press, Wiley Publication
4 Michael Gregg, "Build your own security lab," Wiley India edition
5 Emerging Wireless Technologies and the Future Mobile Internet, Dipankar Raychaudhuri, Mario Gerla, Cambridge.
6 Andreas F.Molisch, "Wireless Communications," Second Edition, Wiley Publications.

Course Code	Course Name	Credits
CSC703	**Artificial Intelligence & Soft Computing**	**4**

Course Objectives (CO):

1 To conceptualize the basic ideas and techniques of AI and SC.

2 To distinguish various search techniques and to make student understand knowledge representation and planning.

3 To become familiar with basics of Neural Networks and Fuzzy Logic.

4 To familiarize with Hybrid systems and to build expert system.

Course Outcomes: Students should be able to -

1 Identify the various characteristics of Artificial Intelligence and Soft Computing techniques.

2 Choose an appropriate problem solving method for an agent to find a sequence of actions to reach the goal state.

3 Analyse the strength and weakness of AI approaches to knowledge representation, reasoning and planning.

4 Construct supervised and unsupervised ANN for real world applications.

5 Design fuzzy controller system.

6 Apply Hybrid approach for expert system design.

Pre-requisites: Basic Mathematics, Algorithms

Module No.	**Unit No.**	**Topics**	**Hrs.**
1.0		**Introduction to Artificial Intelligence(AI) and Soft Computing**	4
	1.1	Introduction and Definition of Artificial Intelligence.	
	1.2	Intelligent Agents : Agents and Environments ,Rationality, Nature of Environment, Structure of Agent, types of Agent	
	1.3	Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques.	
2.0		**Problem Solving**	10
	2.1	Problem Solving Agent, Formulating Problems, Example Problems	
	2.2	Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search	
	2.3	Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm	
3.0		**Knowledge, Reasoning and Planning**	10
	3.1	Knowledge based agents	
	3.2	First order logic: syntax and Semantic, Knowledge Engineering in FOL Inference in FOL : Unification, Forward Chaining, Backward Chaining and Resolution	
	3.3	Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order	
4.0		**Fuzzy Logic**	12

	4.1	Introduction to Fuzzy Set: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, membership functions,	
	4.2	Fuzzy Logic: Fuzzy Logic basics, Fuzzy Rules and Fuzzy Reasoning	
	4.3	Fuzzy inference systems: Fuzzification of input variables, defuzzification and fuzzy controllers.	
5.0		**Artificial Neural Network**	12
	5.1	Introduction – Fundamental concept– Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron	
	5.2	Neural Network Architecture: Perceptron, Single layer Feed Forward ANN, Multilayer Feed Forward ANN, Activation functions, Supervised Learning: Delta learning rule, Back Propagation algorithm.	
	5.3	Un-Supervised Learning algorithm: Self Organizing Maps	
6.		**Expert System**	4
	6.1	Hybrid Approach - Fuzzy Neural Systems	
	6.2	Expert system : Introduction, Characteristics, Architecture, Stages in the development of expert system,	
		Total	52

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach “Second Edition" Pearson Education.
2. Samir Roy and Chakraborty, “Introduction to soft computing”, Pearson Edition.
3. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
4. S.Rajasekaran and G.A.VijayalakshmiPai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
5. N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.

Reference Books:

1. Elaine Rich and Kevin Knight “Artificial Intelligence” Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
2. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
3. Zimmermann H.S "Fuzzy Set Theory and its Applications"Kluwer Academic Publishers.
4. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. JacekM.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO7031	**Advanced System Security and Digital Forensics**	**4**

Course Objectives:

1. To understand cyber attacks and defence strategies.
2. To understand underlying principles of access control mechanisms.
3. To explore software vulnerabilities, attacks and protection mechanisms of wireless networks and protocols, mobile devices and web applications.
4. To develop and mitigate security management and policies.
5. To understand and explore techniques used in digital forensics.

Course Outcomes: At the end of the course learner will able to

1. Understand cyber attacks and apply access control policies and control mechanisms.
2. Identify malicious code and targeted malicious code.
3. Detect and counter threats to web applications.
4. Understand the vulnerabilities of Wi-Fi networks and explore different measures to secure wireless protocols, WLAN and VPN networks.
5. Understand the ethical and legal issues associated with cyber crimes and be able to mitigate impact of crimes with suitable policies.
6. Use different forensic tools to acquire and duplicate data from compromised systems and analyse the same.

Prerequisite: Cryptography and System Security

Module No.	Unit No.	Detailed Content	Hrs.
1	**Introduction & Access Control**		08
	1.1	Cyber-attacks, Vulnerabilities, Defence Strategies and Techniques, Authentication Methods and Protocols, Defence in Depth Strategies.	
	1.2	Access Control Policies: DAC, MAC, Multi-level Security Models: Biba Model, Bell La Padula Model, Single Sign on, Federated Identity Management.	
2	**Program & OS Security**		08
	2.1	Malicious and Non-Malicious programming errors, Targeted Malicious codes: Salami Attack, Linearization Attack, Covert Channel, Control against Program threats.	
	2.2	Operating System Security: Memory and Address protection, File Protection Mechanism, User Authentication.	
	2.3	Linux and Windows: Vulnerabilities, File System Security.	
3	**Web Application Security**		12
		OWASP, Web Security Considerations, User Authentication and Session	

		Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security, OAuth 2.0	
4	**Wireless Security**		08
		Wi-Fi Security, WEP, WPA, WPA-2, Mobile Device Security- Security Threats, Device Security, GSM and UMTS Security, IEEE 802.11/802.11i Wireless LAN Security, VPN Security.	
5	**Legal and Ethical issues**		06
	5.1	Cybercrime and its types, Intellectual property, Privacy, Ethical issues.	
	5.2	Protecting Programs and Data, Information and the Law, Rights of Employees and Employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security, case studies of ethics.	
6	**Digital Forensics**		10
		Introduction to Digital Forensics, Acquiring Volatile Data from Windows and Unix systems, Forensic Duplication Techniques, Analysis of forensic images using open source tools like Autopsy and SIFT, Investigating logs from Unix and windows systems, Investigating Windows Registry.	

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wile**y**

Reference Books:

1. Computer Security, Dieter Gollman, Third Edition, Wiley
2. Digital Forensics by Nilakshi Jain & Kalbande, Wiley.
3. Incident Response & Computer Forensics by Kevin Mandia, Chris Prosise, Wiley.
4. Cyber Security. Nina Godbole, Sunit Belapure, Wiley.

Digital references:

1. https://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of total six question.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

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Laboratory/ Experimental Work

 # The Experiments for this course are required to be performed and to be evaluated in CSL704: Computational Lab-1.

Lab Outcome:

Learner will able to

1. Analyze static code and program vulnerabilities using open source tools.
2. Explore and analyze network vulnerabilities using open source tools.
3. Explore and analyze different security tools to detect web application and browser vulnerabilities.
4. Explore and analyze different tools to secure wireless networks and routers, and mobile devices and perform penetration testing, and analyze its impact.
5. Understand and implement AAA using RADIUS and TACACS.
6. Explore various forensics tools in Kali Linux and use them to acquire, duplicate and analyze data and recover deleted data.

Sr. No	Description
1	Static code analysis using open source tools like RATS, Flawfinder etc.
3	Vulnerability scanning using Nessus, Nikto (Kali Linux)
4	Explore web-application vulnerabilities using open source tools like Wapiti, browser exploitation framework (BeEf), etc.
5	Detect SQL injection vulnerabilities in a website database using SQLMap
6	Performing a penetration testing using Metasploit (Kali Linux)
7	Exploring Router and VLAN security, setting up access lists using Cisco Packet tracer(student edition)
8	Exploring VPN security using Cisco Packet tracer(student edition)
9	Exploring Authentication and access control using RADIUS, TACACS and TACACS+
10	Install and use a security app on an Android mobile (e.g. Droidcrypt)
11	Explore forensics tools in Kali Linux for acquiring, analyzing and duplicating data: dd, dcfldd, foremost, scalpel, debugfs, wireshark, tcptrace, tcpflow
12	Analysis of forensic images using open source tools like Autopsy, SIFT, FKT Imager
13	Use of steganographic tools like OpenStego, to detect data hiding or unauthorized file copying

14.	Use Password cracking using tools like John the Ripper/Cain and Abel/ Ophcrack to detect weak passwords.

Reference Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, Tim Boyles, Sybex.
3. Web Application Hacker's Handbook, Dafydd Stuttard, Marcus Pinto, Wiley India
4. Network Infrastructure Security, Randy Waver, Dawn Weaver, Cengage Learning.
5. Incident Response & Computer Forensics by Kevin Mandia, Chris Prosise, Wiley.

Digital References:

http://www.opentechinfo.com/learn-use-kali-linux/

Course Code	Course/Subject Name	Credits
CSDLO7032	Big Data Analytics	4

Course Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce programming skills to build simple solutions using big data technologies such as MapReduce and scripting for NoSQL, and the ability to write parallel algorithms for multiprocessor execution.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.
5. To provide an indication of the current research approaches that is likely to provide a basis for tomorrow's solutions.

Course Outcomes: Learner will be able to…

1. Understand the key issues in big data management and its associated applications for business decisions and strategy.
1. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Mapreduce and NoSQL in big data analytics.
2. Collect, manage, store, query and analyze various forms of Big Data.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
5. Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Prerequisite:
Some prior knowledge about Java programming, Basics of SQL, Data mining and machine learning methods would be beneficial.

Module	Detailed Contents	Hrs.
01	**Introduction to Big Data and Hadoop** 1.1 Introduction to Big Data, 1.2 Big Data characteristics, types of Big Data, 1.3 Traditional vs. Big Data business approach, 1.4 Case Study of Big Data Solutions. 1.5 Concept of Hadoop 1.6 Core Hadoop Components; Hadoop Ecosystem	06

02	**Hadoop HDFS and MapReduce** 2.1 Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization. 2.2 MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. 2.3 Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce 2.4 Hadoop Limitations	10
03	**NoSQL** 3.1 Introduction to NoSQL, NoSQL Business Drivers, 3.2 NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study 3.3 NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	06
04	**Mining Data Streams:** 4.1 The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. 4.2 Sampling Data techniques in a Stream 4.3 Filtering Streams: Bloom Filter with Analysis. 4.4 Counting Distinct Elements in a Stream, Count-Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements 4.5 Counting Frequent Items in a Stream, Sampling Methods for Streams, Frequent Itemsets in Decaying Windows. 4.6 Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	12
05	**Finding Similar Items and Clustering** 5.1 Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance. 5.2 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries	08
	Real-Time Big Data Models 6.1 PageRank Overview, Efficient computation of	

06	PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 6.2 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering. 6.3 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph.	10

Text Books:

1. CreAnand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.

References books:

1. Bill Franks , "Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
2. Chuck Lam, "Hadoop in Action", Dreamtech Press
3. Jared Dean, "Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley India Private Limited, 2014.
4. 4. Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, "Data Mining and Knowledge Discovery Handbook", Springer, 2nd edition, 2010.
6. Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.
7. Vojislav Kecman, "Learning and Soft Computing", MIT Press, 2010.

Term Work:

Assign a case study for group of 3/4 students and each group to perform the following experiments on their case-study; Each group should perform the exercises on a large datasetcreated by them.

The distribution of marks for term work shall be as follows:

- Programming Exercises: .... (10) Marks.
- Mini project: ..... (10) Marks.
- Attendance (Theory & Practical) ..... (05) Marks.

TOTAL: ..... (25) Marks.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Oral examination:
An oral exam will be held based on the above syllabus.

Suggested Practical List:

1. Hadoop HDFS Practical:
   -HDFS Basics, Hadoop Ecosystem Tools Overview.
   -Installing Hadoop.
   -Copying File to Hadoop.
   -Copy from Hadoop File system and deleting file.
   -Moving and displaying files in HDFS.
   -Programming exercises on Hadoop.
2. Use of Sqoop tool to transfer data between Hadoop and relational database servers.
   a. Sqoop - Installation.
   b. To execute basic commands of Hadoop eco system component Sqoop.
3. To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
4. Experiment on Hadoop Map-Reduce / PySpark:
2. -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
5. Create HIVE Database and Descriptive analytics-basic statistics, visualization using Hive/PIG/R.
6. Write a program to implement word count program using MapReduce.
7. Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language.
8. Implementing any one Clustering algorithm (*K*-Means/CURE) using Map-Reduce.
9. Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc.
10. Implement PageRank using Map-Reduce.
11. Implement predictive Analytics techniques (regression / time series, etc.) using R/ Scilab/ Tableau/ Rapid miner.
12. **Mini Project:** One real life large data application to be implemented (Use standard Datasets available on the web).

 # The Experiments for this course are required to be performed and to be evaluated

in CSL704: Computational Lab-1.

Course Code	Course Name	Credits
CSDLO7033	**Robotics**	**4**

Course objectives:

1 To know basics of a typical robot and its characteristics.
2 To analyse mathematically kinematic modelling of a typical robot manipulator.
3 To identify actuators, sensors and control of a robot for different applications.
4 To apply task planning and vision algorithms.

Course outcomes: On successful completion of course learner will be able to:

1. Describe typical robot and its characteristics.
2. Analyse kinematics parameters of robotic manipulator.
3. Identify actuators, sensors and control of a robot for different applications.
4. Design task plan and motion for a robot.
5. Apply Robotics to solve day to day problems using vision algorithms.
6. Use robot programming languages and acquire skills to program robots.

Prerequisite: Mathematical concepts of Geometry, Matrices Algebra, knowledge of Basic Electronics.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction and Fundamentals of Robotics**	**08**
	1.1	Types of automation, Introduction, definition of a Robot, Classification of Robots, Robotics, History of Robotics, Advantages and Disadvantages of Robots, Robot Applications	
	1.2	Tasks involved in Robotics, Robot Components, Robot characteristics and classification, Degrees of Freedom, Robot joints, Robot Coordinates, Robot Reference frames, Programming Modes, Robot Workspace, Work Envelop.	
2.0		**Direct and Inverse Kinematics**	**08**
	2.1	**Direct (Forward) Kinematics:** Homogeneous coordinates, Link coordinates, Coordinate frame, coordinate transform, Arm equations, An example – Four Axis SCARA.	
	2.2	**Inverse Kinematics:** Inverse kinematics problem, Tool Configuration, An example – Four Axis SCARA.	
		Sensors, Actuators and Drive Systems	**08**

3.0	**3.1**	**Sensors:** Characteristics, Utilization, Types - Position, Velocity, Acceleration, Force and Pressure, Torque, Visible Light and Infrared, Touch and Tactile, Proximity, Range Finders sensors.	
	3.2	**Actuators and Drive System:** Characteristics, Hydraulic Actuators, Pneumatic Devices, Electric Motors	
4.0		**Robot Task and Motion Planning**	**10**
	4.1	Reactive Paradigms: Overview, Attributes of reactive paradigm	
	4.2	Task level programming, Uncertainty, Configuration Space, Gross motion planning, Fine-motion planning, Simulation of Planner motion, Source and goal scene, Task planner Simulation.	
	4.3	Robot Motion Planning: Concept of motion planning, BUG 1, BUG 2 and Tangent Bug Algorithms	
5.0		**Robot Vision**	**10**
	5.1	Image Representation, Template Matching, Polyhedral Objects	
	5.2	Shape Analysis, Iterative Processing	
	5.3	Perspective Transformations, Structured Illumination , Camera Calibration	
6.0		**Expert Systems, Robot Language and Fuzzy Logic**	**12**
	6.1	Introduction to Expert Systems, Expert system Characteristics, Robot as a Expert System, Robot Languages: Classification of Robot Languages, Computer Control and Robot Software, VAL System, and Language.	
	6.2	Introduction, Fuzzy set, Fuzzification, Fuzzy Inference Rule Base, Defuzzification, Applications of Fuzzy Logic in Robotics.	
		Total	**52**

Text Books:

1. Introduction Robotics - Analysis, Control, Applications by Saeed B. Niku, Second Edition, Wiley India.
2. Fundamentals of Robotics – Analysis and Control by Robert J. Schilling, Pearson
3. Introduction to AI robotics by Robin Murphy, PHI.

4. Robotics Technology and Flexible Automation by S. R. Deb, TMH.
5. Artificial Intelligence by Rich, Knight and Nair, TMH.
6. Introduction to Fuzzy Sets by M Ganesh PHI

Reference Books:

1. Robotics – Control, Sensing, Vision, and Intelligence by K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Tata McGraw Hill
2. Principles of Robot Motion – Theory, Algorithms and Implementation by Howie Choset, Lynch, PHI
3. Introduction to Fuzzy Logic using Matlab,By: S.N.Sivanandam,S.N.Deepa,P Sumathi , Springer Publications

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Term Work :

The distribution of marks for term work shall be as follows:

• Programming Exercises: .... (10) Marks.
• Mini project: ..... (10) Marks.
• Attendance (Theory & Practical) ..... (05) Marks.
TOTAL: ..... (25) Marks.

Suggested List of Experiments:

1 Representation of Various Robots and there all Specification (Study Experiment)

2 Co-ordinate Transform of a Robot

3 Fundamental Rotation

4 Composite Rotation

5 BFS and DFS

6 Homogeneous Rotation

7 Run Length Encoding

8 Shrink and swell Operator

9 BUG1 Algorithm

10 Bug2 Algorithm

11 Tangent Bug Algorithm

12 Edge detection algorithm

13 Case Study of CNC Machine

14 Designing a Robot Manipulator for Pre defined Task

Students can perform experiments based on Theory Syllabus or any 12 experiments from above list of experiments or experiments framed by teachers.

 # The Experiments for this course are required to be performed and to be evaluated in CSL704: Computational Lab-1.

Course Code	Course Name	Credits
ILO 7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development,	05

	Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology	07

	5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05

04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures:	09

	5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity,	10

	factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	**Development Engineering**	**03**

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Module Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	**04**
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**
04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	**10**

	Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
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First test based on approximately 40% of contents and second test based on remaining contents (approximately
40% but excluding contents covered in Test I)

End Semester Examination:
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3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

Lab Code	Lab Name	Credits
CSL701	**Digital Signal and Image Processing Lab**	**1**

Lab Outcome: The learner will be able to

1. Sample and reconstruct the signal.
2. Implement and apply operations like Convolution, Correlation, DFT and FFT on DT signals
3. Implement spatial domain Image enhancement techniques.
4. Implement Edge detection techniques using first order derivative filters.

Description:

Implementation of programs can be in C or C++ or any computational software. A List of ten experiments is given below, are needed to be performed covering all syllabus modules. Additional experiments within the scope of the syllabus can be added.

Suggested List of Experiments:

1. Sampling and Reconstruction
2. To perform Discrete Correlation
3. To perform Discrete Convolution
4. To perform Discrete Fourier Transform
5. To perform Fast Fourier Transform
6. Implementation of Image negative, Gray level Slicing and Thresholding
7. Implementation of Contrast Stretching ,Dynamic range compression & Bit plane Slicing
8. Implementation of Histogram Processing
9. Implementation of Image smoothing/ Image sharpening
10. Implementation of Edge detection using Sobel and Previtt masks

Term Work:

- Laboratory work will be based on above syllabus of CSC701 - 'Digital Signal and Image Processing' with minimum 10 experiments to be incorporated.
- The distribution of marks for term work shall be as follows:

Lab Performance	15 Marks
Assignments	05 Marks
Attendance (Theory & practical)	05 Marks

Lab Code	Lab Name	Credits
CSL702	Mobile Application Development Lab	1

Lab Outcome:

1. To develop and demonstrate mobile applications using various tools
2. Students will articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
3. Students will able to carry out simulation of frequency reuse , hidden terminal problem
4. To develop security algorithms for mobile communication network
5. To demonstrate simulation and compare the performance of Wireless LAN
6. To implement and demonstrate mobile node discovery and route maintains.

Description: The softwares like Android Studio, J2ME, NS2, NS3 and any other software which is suitable are recommended for performing the practicals.

Suggested List of Experiments:

Sr. No.	Title of Experiments
01	To understand the cellular frequency reuse concept to find the co-channel cells for a particular cell. Design a game based application on the above concept.
02	To understand the cellular frequency reuse concept to find the cell clusters within certain geographic area. Design a game based application on the above concept.
03	Implementation a Bluetooth network with application as transfer of a file from one device to another.
04	To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonality and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.
05	To implement Mobile node discovery
06	Implementation of GSM security algorithms (A3/A5/A8)
07	Illustration of Hidden Terminal Problem (NS-2) Consider two Wifi base stations (STA) and an access point (AP) located along the x-axis. All the nodes are fixed. The AP is situated at the middle of the two STA, the distance of separation being 150 m. [variable]. Node #0 and node #1 are the hidden terminals. Both are transmitting some data to the AP (almost at same rate) at the same time. The loss across the wireless link between each STA and the AP is fixed at 50 dB irrespective of the distance of separation. To study how RTS/CTS helps in wireless networks, 1. No RTS/CTS is being sent. 2. Nodes do exchange RTS/CTS packets. **Compare the no. of packet retransmissions required in both the cases (as obtained in the output) and compare the results.**

08	To setup & configuration of Wireless Access Point (AP) using NS3. Analyze the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS). Consider BS and AP are static. Find out the maximum distance to which two way communications is possible. Try multiple iterations by adjusting its distance in the code and test it.
09	Develop an application that writes data to the SD card.
10	Develop an application that uses GUI components.
11	Write an application that draws basic graphical primitives on the screen.
12	Develop an application that makes use of database.
13	Develop a native application that uses GPS location information.
14	Implement an application that creates an alert upon receiving a message.
15	Implementation of income tax/loan EMI calculator and deploy the same on real devices.

Digital Material (if Any):

1. http://www.isi.edu/nsnam/ns/ : NS-2 software download
2. https://nsnam.isi.edu/nsnam/index.php/NS_manual
3. https://www.nsnam.org/ : Ns-3 Software Download
4. http://vlssit.iitkgp.ernet.in/ant/ant/

Text Books:

1. Jochen Schilller,"Mobile Communication ", Addision wisely,Pearson Education
2. "Wireless Communications & Networks," By William Stallings, Second Edition, Pearson Education
3. Ekram Hossain and Teerawat Issariyakul, "Introduction to Network Simulator NS-2," Springer , Second Edition.
4. Michael Burton, "Android Appliocation Development for Dummies, " A wiley brand
5. Marko Gargenta & Masumi Nakamura, " Learning Android," O'reilly publications
6. James Keogh, "The complete reference J2ME, " Mcgraw-Hill.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Laboratory work (experiments): …… (15) Marks.

Assignments: ……..... (05) Marks.

Attendance (Theory + Practical)…… (05) Marks

TOTAL: …… (25) Marks.

Oral & Practical exam will be based on the above and CSC702: Mobile Communication & Computing syllabus.

Lab Code	Lab Name	Credits
CSL703	**Artificial Intelligence & Soft Computing Lab**	**1**

Lab Outcomes: Learner will be able to

1 To realize the basic techniques to build intelligent systems

2 To create knowledge base and apply appropriate search techniques used in problem solving.

3 Apply the supervised/unsupervised learning algorithm.

4 Designfuzzy controller system.

Description: The current applications from almost all domains, like games, robots, expert system, optimization or even the search engines are becoming smarter. We have moved to the era of knowledge processing from data and information processing. Therefore learning these technologies practically is very essential for a student to gain the proficiency. They will also learn and be able to appreciate the use of fusion of basic techniques.

LAB	**Topic / Activity**	**Explanation of Activity**
Lab 1	• Identify the problem • PEAS Description • Problem formulation	Select a problem statement relevant to AI
Lab 2	Introduce AI programming Language	Introduce PROLOG programming.
Lab 3	• Start Implementation • Knowledge Representation and Create Knowledge Base	Use AI programming languages Or C/JAVA
Lab 4	Implement search algorithms to reach goal state	Identify and analyse Algorithm to solve the problem
Lab 5	To implement Mc-Culloch Pitts Model for a problem	Apply to solve AND / OR/ XOR, etc.
Lab 6	To implement Fuzzy Controller system	Design an automobile or washing machine controller, etc. and implement
Lab 7	To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem.	Design a NN using a learning method to generate knowledge for classification.
Lab 8	Case study on Hybrid Systems	Study the designing of Neuro Fuzzy systems
Lab 9	Case study of an Application	Printed Character Recognition, Face Recognition, etc.

Term Work:

1. Labs 1-4 are to design and implement an intelligent system using AI techniques.
2. Labs 5-7 are to design and implement an Intelligent System using SC techniques.
3. Perform any one from Lab 8 and lab 9.

The distribution of marks for term work shall be as follows:

Lab Performance (Experiments /case studies):	15
Assignment	05
Attendance (Theory & Practical)	05

Oral examination will be based on the above and **CSC703**: '**AI and SC**' Syllabus.

Lab Code	Lab Name	Credits
CSL703	**Computational Lab-I**	**1**

Lab Outcome: After successful completion of this course student will be able to:

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.

Description:
Design and implementation of any case study/ applications /experiments / mini project based on departmental level optional courses using modern tools.

Term work:

The distribution of marks for **term work** shall be as follows:

Lab/ Experimental Work	:	15
Report/ Documentation	:	05
Attendance (Theory & Practical)	:	05

Practical & Oral examination is to be conducted based on respective departmental level optional courses by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Title	Credit
CSP705	**Major Project- I**	**3**

Objective: The Project work enables students to develop further skills and knowledge gained during the programme by applying them to the analysis of a specific problem or issue, via a substantial piece of work carried out over an extended period. For students to demonstrate proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. **Project Topic:**
   - To proceed with the project work it is very important to select a right topic. Project can be undertaken on any subject addressing IT programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
   - Project work must be carried out by the group of at least two students and maximum three and must be original.
   - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
   - The project work can be undertaken in a research institute or organization/company/any business establishment.
   - Student must consult internal guide along with external guide (if any) in selection of topic.
   - Head of department and senior staff in the department will take decision regarding selection of projects.
   - Student has to submit weekly progress report to the internal guide and where as internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
   - In case of industry projects, visit by internal guide will be preferred.

2. **Project Report Format:**

   At the end of semester a project report should preferably contain at least following details:-

   - Abstract
   - Introduction
   - Literature Survey
     - Survey Existing system
     - Limitation Existing system or research gap
     - Problem Statement and Objective
     - Scope
   - Proposed System
     - Analysis/Framework/ Algorithm
     - Details of Hardware & Software
     - Design details
     - Methodology (your approach to solve the problem)

- Implementation Plan for next semester
- Conclusion
- References

3. **Term Work:**
   Distribution of marks for term work shall be as follows:
   a. Weekly Attendance on Project Day
   b. Project work contribute
   c. Project Report (Spiral Bound)
   d. Term End Presentation (Internal)

   The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**
   Oral &Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-I.

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC801	Human Machine Interaction	4	-	-	4	-	-	4
CSC802	Distributed Computing	4	-	-	4	-	-	4
CSDLO 801X	Department Level Optional Course -IV	4	-	-	4	-	-	4
ILO801X	Institute Level Optional Course-II	3	-	-	3	-	-	3
CSL801	Human Machine Interaction Lab	-	2	-	-	1		1
CSL802	Distributed Computing Lab		2			1		1
CSL803	Cloud Computing Lab	-	4	-	-	2		2
CSL804	Computational Lab-II	-	2	-		1		1
CSP805	Major Project-II	-	12			6	-	6
	Total	**15**	**22**	-	**15**	**11**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab	-	-	-	-	-	25	25		50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50	--	50	100
Total		80	80	80	320	--	200	50	100	750

Sem.	Department Level Optional Course (DLOC)	Institute Level Optional Course (ILOC)
V	CSDLO5011: Multimedia System CSDLO5012: Advance Operating System CSDLO5013: Advance Algorithm	----------
VI	CSDLO6021: Machine Learning CSDLO6022: Advance Database System CSDLO6023: Enterprise Resource Planning CSDLO6024: Advance Computer Network	----------
VII	CSDLO7031: Advance System Security & Digital Forensics CSDLO7032: Big Data & Analytics CSDLO7033: Robotics	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering
VIII	DLO8011: High Performance Computing DLO8012: Natural Language Processing DLO8013: Adhoc Wireless Network	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Name	Credits
CSC801	**Human Machine Interaction**	**4**

.**Course Objectives:** At the end of the course, students will be able to –

1. Learn the foundation of human machine interaction.
2. Understand the importance of human psychology in designing good interfaces.
3. Be aware of mobile interaction design and its usage in day – to – day activities.
4. Understand various design technologies to meet user requirements.
5. Encourage to indulge into research in Machine Interaction Design.

Course Outcomes: At the end of the course, the students will be able to -

1. Identify User Interface (UI) design principles.
2. Analysis of effective user friendly interfaces.
3. Apply Interactive Design process in real world applications.
4. Evaluate UI design and justify.
5. Create application for social and technical task.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc

Module No.	**Topics**	**Hrs.**
1.0	**FOUNDATIONS OF HMI:** The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving . The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.	8
2.0	**DESIGN & SOFTWARE PROCESS**: Mistakes performed while designing a computer system, Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds .Interactive Design basics, process, scenarios, navigation, Iteration and prototyping. HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process. Evaluation Techniques: Universal Design.	10
3.0	**GRAPHICAL USER INTERFACE:** The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.	8

4.0	**SCREEN DESIGNING**: Design goals , Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.	10
5.0	**INTERFACE DESIGN FOR MOBILE DEVICES**: Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	8
6.0	**INTERACTION STYLES AND COMMUNICATION**: Windows:Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia and colors	**8**
	Total	**52**

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rdEdition, Pearson Education, 2004.
2. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, "About Face3: Essentials of Interaction design", Wiley publication.
4. Jeff Johnson, "Designing with the mind in mind", Morgan Kaufmann Publication.
5. Donald A. Normann, " Design of everyday things",Basic Books; Reprint edition 2002.
6. Brian Fling, "Mobile Design and Development", First Edition , O'Reilly Media Inc., 2009.

Reference Books:

1. Rogers Sharp Preece,"Interaction Design:Beyond Human Computer Interaction",,Wiley.
2. Guy A. Boy "The Handbook of Human Machine Interaction", Ashgate publishing Ltd.
3. Kalbande,Kanade,Iyer,"Galitz's Human Machine Interaction", Wiley Publications.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC802	**Distributed Computing**	**04**

Course objectives:

1. To provide students with contemporary knowledge in distributed systems
2. To equip students with skills to analyze and design distributed applications.
3. To provide master skills to measure the performance of distributed synchronization algorithms

Course outcomes: On successful completion of course learner will be able to:

1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies;
2. Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3. Analyze the various techniques used for clock synchronization and mutual exclusion
4. Demonstrate the concepts of Resource and Process management and synchronization algorithms
5. Demonstrate the concepts of Consistency and Replication Management
6. Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

Prerequisite: Java Programming, Operating Systems, Computer Networks

Module No.	Unit No.	Topics	Hrs.
1.0	**Introduction to Distributed Systems**		**06**
	1.1	Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept.	
	1.2	Middleware: Models of Middleware, Services offered by middleware, Client Server model.	
2.0	**Communication**		**10**
	2.1	Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI)	
	2.2	Message Oriented Communication, Stream Oriented Communication, Group Communication	
3.0	**Synchronization**		**10**
	3.1	Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure.	
	3.2	Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm	
	3.3	Token Based Algorithms: Suzuki-Kasami's Broardcast Algorithms, Singhal's Heurastic Algorithm, Raymond's Tree based Algorithm, Comparative Performance Analysis.	
4.0	**Resource and Process Management**		**06**
	4.1	Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach	
	4.2	Introduction to process management, process migration, Threads,	

		Virtualization, Clients, Servers, Code Migration	
5.0	**Consistency, Replication and Fault Tolerance**		**08**
	5.1	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management	
	5.2	Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery	
6.0	**Distributed File Systems and Name Services**		**12**
	6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Distributed File Systems (DSF), Network File System (NFS), Andrew File System (AFS)	
	6.2	Introduction to Name services and Domain Name System, Directory Services, Case Study: The Global Name Service, The X.500 Directory Service	
	6.3	Designing Distributed Systems: Google Case Study	
		Total	**52**

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

a. Question paper will comprise of 6 questions, each carrying 20 marks.
b. The students need to solve total 4 questions.
c. Question No.1 will be compulsory and based on entire syllabus.
d. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, , "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

Reference Books:

1. A. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
2. M. L. Liu, “Distributed Computing Principles and Applications”, Pearson Addison Wesley, 2004.

Course Code	Course Name	Credit
DLO8011	**High Performance Computing**	04

Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms.

Course Outcomes: Learner will be able to-

1. Memorize parallel processing approaches
2. Describe different parallel processing platforms involved in achieving High Performance Computing.
3. Discuss different design issues in parallel programming
4. Develop efficient and high performance parallel programming
5. Learn parallel programming using message passing paradigm using open source APIs.

Prerequisite: Computer Organization

Sr.No.	Module	Detailed Content	Hours
1	Introduction	**Introduction to Parallel Computing:** Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function) **Classification Models**: Architectural Schemes (Flynn's, Shore's, Feng's, Handler's) and Memory access (Shared Memory, Distributed Memory, Hybrid Distributed Shared Memory) **Parallel Architectures:** Pipeline Architecture, Array Processor, Multiprocessor Architecture, Systolic Architecture, Data Flow Architecture	6
2	Pipeline Processing	Introduction, Pipeline Performance, Arithmetic Pipelines, Pipeline instruction processing, Pipeline stage design, Hazards, Dynamic instruction scheduling	8
3	Parallel Programming Platforms	Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor & Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	10
4	Parallel Algorithm Design	Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models	12

5	Performance Measures	Performance Measures : Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks	6
6	HPC Programming	Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations **MPI:** the Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Introduction to OpenMP	10

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. M. R. Bhujade, "Parallel Computing", 2nd edition, New Age International Publishers, 2009.
3. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.

Reference Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks.
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Laboratory Work:

Description: The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

Suggested Experiment List:

Sr. No.	Detailed Content
1	Execution of Simple Hello world program on MPI platform
2	a. Program to send data and receive data to/from processors using MPI b. Program illustrating Broadcast of data using MPI
3	Implement a parallel program to demonstrate the cube of N number within a set range.
4	Write a parallel program for area of a circle/triangle
5	Implement a program to demonstrate balancing of workload on MPI platform
6	Using directives of MPI/OpenMP implement parallel programming for calculator application (add, sub, multiplication and division)
7	**Mini Project** Evaluate performance enhancement of HPC for any of the following: One-Dimensional Matrix-Vector Multiplication/ Single-Source Shortest-Path/ Sample Sort/Two-Dimensional Matrix-Vector Multiplication

Course Code	Course Name	Credits
DLO8012	**Natural Language Processing**	**4**

Course objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing
4. To implement various language Models.
5. To design systems that uses NLP techniques

Course outcomes: On successful completion of course learner should:

1. Have a broad understanding of the field of natural language processing.
2. Have a sense of the capabilities and limitations of current natural language technologies,
3. Be able to model linguistic phenomena with formal grammars.
4. Be able to Design, implement and test algorithms for NLP problems
5. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP
6. Be able to apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory.

Module No.	Unit No.	Topics	Hrs.
1	**Introduction**	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP	4
2	**Word Level Analysis**	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST Porter stemmer. N –Grams- N-gram language model, N-gram for spelling correction.	10
3	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	10
4	**Semantic Analysis**	Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD) ,Dictionary based approach	10

5	**Pragmatics**	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference	8
6	**Applications (preferably for Indian regional languages)**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition.	10

Text Books:

1. Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.

Reference Books:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni " Multilingual natural language processing applications" Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) " The Handbook of Computational Linguistics and Natural Language Processing " ISBN: 978-1-118-
4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
5. Brian Neil Levine, An Introduction to R Programming
6. Niel J le Roux, Sugnet Lubbe, A step by step tutorial : An introduction into R application and programming

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Laboratory Work/Case study/Experiments:

Description: The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: **http://cse24-iiith.virtual-labs.ac.in/#**

Reference for NPTEL: http://www.cse.iitb.ac.in/~cs626-449

Sample Experiments: possible tools / language: R tool/ Python programming Language

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Preprocessing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2. Morphological Analysis
3. N-gram model
4. POS tagging
5. Chunking
6. Named Entity Recognition
7. Case Study/ Mini Project based on Application mentioned in Module 6.

Course Code	Course Name	Credits
DLO8013	Adhoc Wireless Networks	4

Course objectives:

1. To Identify the major issues associated with ad-hoc networks
2. To identify the requirements for protocols for wireless ad-hoc networks as compared to the protocols existing for wired network.
3. To explore current ad-hoc technologies by researching key areas such as algorithms, protocols, hardware, and applications.
4. To Provide hands-on experience through real-world programming projects
5. To provide advanced in–depth networking materials to graduate students in networking research.

Course outcomes: On successful completion of course learner will be able to:

1. Identify the characteristics and features of Adhoc Networks.
2. Understand the concepts & be able to design MAC protocols for Ad Hoc networks
3. Implement protocols / Carry out simulation of routing protocols of Adhoc Networks
4. Interpret the flow control in transport layer of Ad Hoc Networks
5. Analyze security principles for routing of Ad Hoc Networks
6. Utilize the concepts of Adhoc Networks in VANETs

Prerequisite: Computer Network, Wireless Networking

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**04**
	1.1	Introduction to wireless Networks. Characteristics of Wireless channel,	
	1.2	Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models,	
	1.3	Introduction to Adhoc networks – definition, characteristics features, applications.	
2.0		**MAC protocols for Wireless Ad-Hoc Networks**	**12**
	2.1	Introduction	
	2.2	Issues in designing MAC for Wireless Ad-Hoc Networks	
	2.3	Design Goals and classification of MAC for Wireless Ad-Hoc Networks	
	2.4	Contention based MAC protocols for Wireless Ad-Hoc Networks, with reservation mechanisms, scheduling Mechanisms	
	2.5	MAC protocols using directional antennas, Other MAC Protocols	
	2.6	IEEE standards MAC Protocols: 802.15.1(WPAN based on Bluetooth), 802.15.4 (WSN/Zigbee), 802.15.6 (WBAN).	
3.0		**Routing Protocols for Wireless Ad-Hoc Networks**	**10**
	3.1	Introduction, Issues in designing a routing protocol for Wireless Ad-Hoc Networks	
	3.2	Classification of routing protocols, Table driven routing protocols like DSDV, WRP,	

		On- demand routing protocols like ABR, DSR, TORA, AODV, etc.	
	3.3	Hybrid Routing Protocols : ZRP, Routing Protocols with efficient flooding mechanism, Hierarchical Routing Protocols, Power aware routing protocols	
4.0		**Transport Layer**	**10**
	4.1	Transport layer protocols for Ad hoc wireless Networks: Introduction,	
	4.2	Issues in designing a transport layer protocol for Ad hoc wireless Networks,	
	4.3	Design goals of a transport layer protocol for Ad hoc wireless Networks,	
	4.4	Classification of transport layer solutions: Split Approach , End-to-End approach :TCP-F,TCP-ELFN, Ad-Hoc TCP, TCP Buffering capability and Sequencing information	
	4.5	End-to-End Quality of Service	
5.0		**Security**	**08**
	5.1	Security attacks in wireless Ad hoc wireless Networks, Network security requirements,	
	5.2	Issues & challenges in security provisioning,	
	5.3	Link Layer security attacks: 802.11 MAC , WPA and variations	
	5.4	Network Security Attacks: Routing Protocol Attacks: attacks using falsifying route errors and broadcasting falsifying routes, spoofing attacks, Rushing attacks, Secure routing in Ad hoc wireless Networks	
6.0		**Vehicular Ad-Hoc Network (VANET)**	**08**
	6.1	Introduction: Challenges and Requirements, , Layered architecture for VANETs, DSRC /WAVE standard (IEEE 802.11p)	
	6.2	IEEE 802.11p protocol Stack (PHY & MAC) , A Survey on Proposed MAC Approaches for VANETs like TDMA, SDMA and CDMA based approaches, DSRC MAC & LLC	
	6.3	Georouting: CBF, Flooding with broadcast suppression	
	6.4	Delay Tolerant Network, Introduction to Opportunistic Networking in Delay Tolerant Vehicular Ad Hoc Networks	
		Total	**52**

Assessment:

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Siva Ram Murthy and B.S. Manoj , "Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education, 2007 **(T1)**
2. C. K. Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 2002 **(T2)**
3. Charles E. Perkins, "Adhoc Networking", Addison – Wesley, 2000 **(T3)**
4. Dipankar Raychaudhuri, Mario Gerla, "Emerging Wireless Technologies and the Future Mobile Internet, D, Cambridge. **(T4)**

Reference Books:

1. Subir Kumar Sarkar, "Ad-Hoc Mobile Wireless Networks: principles, protocols and applications" CRC Press **(R1)**
2. Prasant Mohapatra and Sriramamurthy, "Ad Hoc Networks: Technologies and Protocols", Springer International Edition, 2009, **(R2)**
3. Stefano Basangi, Marco Conti, Silvia Giordano, Ivan Stojmenovic, "Mobile Ad-Hoc Networking, " John-Wiley and Sons Publications, 2004,**(R3)**
4. Hannes Hartenstein, Kenneth Laberteaux, "VANET Applications and Interworking Technologies," Wiley Publications (R4)
5. Christoph Sommer , Falko Dressler, "Vehicular Networking," Cambridge University Press, 2014 **(R5)**

Laboratory Work

Lab Outcome:

1. Explore the knowledge of NS2 and NS3 by installing it and make it ready
2. Shall synthesize a simulation and evaluate the performance of WLAN 802.11 and Bluetooth
3. Students will able to analyze and implement MAC & Network layer protocols using open source and synthesis as well as evaluate its performance
4. Implement Transport layer protocols / Carry out simulation of routing protocols of Adhoc Networks
5. Describe and interpret the use security routines and evaluate its performance
6. Explore and understand the capability of SUMO and MOVE as well as Nessi by installing it and analyze it by applying on various scenarios

Description: It is recommended that Network simulation Softwares like NS-2, NS-3, SUMO (Simulation software for Urban MObility) with MOVE. Software like Nessi is also recommended for the event based security attacks simulation and measure.

The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Installation of NS2 & NS3 in Fedora 19 (32 bit) OS Linux.
2	Simulating IEEE 802.11 wireless LAN in Ad-Hoc Mode using NS2
3	Implementation a Bluetooth network in NS3 with application as transfer of a file from one device to another
4	To implement and compare MAC layer protocols, MACAW, MACA-BI and MACA with piggybacked Reservation using NS-3

5	Develop sample wireless network in which a. implement AODV and AOMDV protocol b. Calculate the time to receive reply from the receiver using NS2. c. Generate graphs which show the transmission time for packet. Implement wireless network. Capture data frame and identify fields using NS2.
6	Communicate between two different networks (NS-3) which has following specifications: a. One network has Class A network with "TORA protocol" b. Second has Class B network "AODV protocol"
7	To calculate and compare average throughput for various TCP variants like TCP-F (Feedback) and Ad-Hoc TCP using NS-3
8	Explore and use security tools like WEP & WPA and evaluate its performance on mobile terminals
9	Simulation of Urban Mobility (SUMO) along with MOVE is software that helps in simulating the VANETs. Install it on Fedora 19 (32 bit) OS Linux
10	Create a simulation for road traffic with 6 junctions. There are various vehicles going on and your own car also. Select a shortest route for your car. Demonstrate with simulation software SUMO and MOVE.
11	A car acts as a malicious node and can be analyzed for the packet loss before and after malicious activity. Using SUMO and MOVE.
12	Create an Ad-hoc Network using nessi Simulation software and include events incorporate dropped packets, infected flows, compromised machines, unavailable services etc, and check its performance

Digital Material (if Any):

1. http://www.isi.edu/nsnam/ns/ : NS-2 software download (D1)
2. https://nsnam.isi.edu/nsnam/index.php/NS_manual (D2)
3. https://www.nsnam.org/ : Ns-3 Software Download (D3)
4. http://www.nsnam.com/2013/11/vanet-simulator-in-fedora-19-32-bit.html (D4)
5. http://www.sumo.dlr.de/userdoc/Tutorials/Quick_Start.html (D5)
6. http://veins.car2x.org/ (D6)
7. http://www.nessi2.de/ (D7)

Text Books:

1. Ekram Hossain and Teerawat Issariyakul, "Introduction to Network Simulator NS-2," Springer , Second Edition. (T1)
2. Jack L. Burbank, "Introduction to Network Simulator 3," Wiley Publications(T2)
3. Siva Ram Murthy and B.S. Manoj , "Ad hoc Wireless Networks Architectures and protocols", 2nd edition, Pearson Education, 2007 (T3)
4. Michael Gregg, "Build your own security lab," Wiley India edition (T4)

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit	8

	5.3 Project Contracting Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management,Gido Clements, Cengage Learning
4. Project Management,Gopalan, Wiley India
5. Project Management,Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine	05

	Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6

04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**

05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO 8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Lab Code	Lab Name	Credits
CSL801	Human Machine Interactions Lab	1

Lab Outcome:

1: To design user centric interfaces.
2: To design innovative and user friendly interfaces.
3: To apply HMI in their day-to-day activities.
4: To criticize existing interface designs, and improve them.
5: To Design application for social Task.
6: To Design application for Technical Tasks

Description:

Human Machine Interaction provides the study of user interface and benefit of good design. The design process gives an idea about how people interact with computer and the problems that they fall, so understanding the human characteristics is important as this lays the base for a good interface. It enables the students to apply his/her design skills to develop an appropriate Mobile App or Website. Students also learn the different types of icon, color and its representation with social and ethical concerns. Students can also learn the different software tools used to assemble and build user interface along with the different types of interaction devices and finally try to measure the usability of the application by learning HMI principles.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Problem representation for Designing User Interface
2	Design a Mobile app/ Website that can teach mathematics to children of 4-5 years age in schools in Rural /Urban Sector
3	Design a Mobile App/Website that can help people to sell their handmade products in metro cities
4	ATM machine/KIOSK screen design for rural people.
5	Design a Mobile App/Website to get an experience for passengers whose flight /train is delayed.
6	Design an UI application for Institute event management.
7	Design of User interface for the system using various interaction styles.
8	Statistical Graphics and its use in visualization
9	Design appropriate icons pertaining to a given domain .(Eg. Greeting cards)

10	Design a personal website for an Artisan
11	Design a interface for Home appliances
12	Design an interactive data access using Graphics (QR, BAR Code, Image etc) and generating a print form
13	Redesign of a user interface (Suggest and implement changes in Existing User Interface
14	Design a navigator for a student new in your Institute.
15	Design a navigator for a person new in tourist city/ village
16	Design UI for Motor paralysis for disabled people.
17	KIOSK design for hospital/school/educational campus/National Institute.
18	To calculate screen complexity of existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Guidelines:

1. Students are expected to use advanced tools and Technologies towards execution of lab work.
2. Students can work individually or only 2-3 Students can form a team if they wish to work in Group.
3. Case Study and assignments may be linked with CSC801 Syllabus.

Term Work:

Laboratory work will be based on above syllabus with minimum 10(Ten) experiments in line with the above Lab outcomes to be incorporated with 13(Thirteen) lab session of 2 (two) hours each. The problem statement can be decided by the instructor in line with the above list of experiments

The distribution of 25 marks for term work shall be as follows:

Lab Performance	15
Mini Project	05
Attendance (Theory & Practical)	05

Oral exam will be based on the above and CSC801:'HMI Theory' Syllabus.

Lab Code	Lab Name	Credits
CSL802	**Distributed Computing Lab**	**01**

Lab Outcome:

1. Develop, test and debug RPC/RMI based client-server programs.
2. Implement the main underlying components of distributed systems (such as IPC, name resolution, file systems etc.)
3. Implement various techniques of synchronization.
4. Design and implement application programs on distributed systems.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Client/server using RPC/RMI.
2	Implementation of multi tread application
3	Inter-process communication
4	Group Communication
5	Load Balancing Algorithm.
6	Name Resolution protocol.
7	Election Algorithm.
8	Clock Synchronization algorithms.
9	Mutual Exclusion Algorithm.
10	Deadlock management in Distributed systems
11	Distributed File System
12	CORBA

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Laboratory work (experiments): …… (15) Marks.
Assignments: ……..... (05) Marks.
Attendance (Theory + Practical)…… (05) Marks
TOTAL: …… (25) Marks.

Oral exam will be based on the above and CSC802 syllabus.

Lab Code	Course Name	Credits
CSL803	**Cloud Computing Lab**	**2**

Lab Objectives: The course will help the learners to get familiar with

1. Key concepts of virtualization.
2. Various deployment models such as private, public, hybrid and community.
3. Various service models such as IaaS and PaaS.
4. Security and Privacy issues in cloud.

Lab Outcomes: On completion of the course learners will be able to

1. Adapt different types of virtualization and increase resource utilization.
2. Build a private cloud using open source technologies.
3. Analyze security issues on cloud.
4. Develop real world web applications and deploy on commercial cloud.
5. Demonstrate various service models.

Module	Detailed Contents	Hours
01	**Title:** Study of NIST model of cloud computing. **Objective:** Understand deployment models, service models, advantages of cloud computing.	2
02	**Title:** Virtualization. **Objective**: Understand different types of virtualizations, Host and bare metal hypervisors and implement horizontal scalability. **Technology:** XEN/ Vmwares EXSi	2
03	**Title:** Infrastructure as a Service. **Objective:** Implement IaaS using your resources. **Technology:** Open Stack / Eucalyptus	2
04	**Title:** Identity Management in Cloud **Concept:** Simulate identity management in your private cloud. **Technology:** Open Stack	2
05	**Title:** Storage as a Service **Objective:** Explore Storage as a Service for remote file access using web interface. **Technology:** ownCloud	2
06	**Title:** Cloud Security **Objective:** Understand security of web server and data directory. **Technology:** ownCloud	2
07	**Title:** Platform as a Service **Objective:** Deploy web applications on commercial cloud. **Technology:** Google appEngine/ Windows Azure	2
08	**Title:** Amazon Web Service **Objective:** To create and access VM instances and demonstrate various	2

	components such as EC2, S3, Simple DB, DynamoDB. **Technology:** AWS	
09	**Title:** Software as a Service **Objective:** Understand on demand application delivery and Virtual desktop infrastructure. **Technology:** Ulteo	2
10	**Title: Case Study on Fog Computing** **Objective**: To have a basic understanding of implementation/applications of fog computing.	2
11	**Title:** Mini Project **Objective:** Using the concepts studied throughout the semester students shall be able to 1. Create their private cloud for the institute using the available resources. 2. Apply security concepts to secure a private cloud. 3. Implement efficient load balancing. 4. Compare various virtualization technologies with given resource. 5. Create cloud applications such as messenger, photo editing website, your own social media etc. **Note:** Evaluators must check if students have used appropriate cloud computing tools for their projects.	6

Digital Material

www.openstack.org

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 ,
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013

Term Work:

- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.
- The distribution of marks for term work shall be as follows:
- Laboratory work (experiments): …….. (15) Marks.
- Mini project..... …… (15) Marks.
- Mini Project Presentation & Report..... (10) Marks
  Assignments..... (05) Marks
- Attendance ……..(05) Marks
- **TOTAL: ……(50) Marks.**

Practical and Oral examination will be based on Laboratory work, mini project and above syllabus.

Lab Code	Course Name	Credits
CSL804	**Computational Lab II**	**1**

Lab Outcome: After successful completion of this course student will be able to:

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.

Description:
Design and implementation of any case study/ applications /experiments / mini project based on departmental level optional courses using modern tools.

Term work:

The distribution of marks for **term work** shall be as follows:

Lab Experimental Work & mini project	:	25
Report/ Documentation/Presentation	:	20
Attendance (Theory & Practical)	:	05

Practical & Oral examination is to be conducted based on departmental level optional courses by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Title	Credit
CSP805	**Major Project- II**	**6**

Objective: The primary objective is to meet the milestone s formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of semester a student need to prepare a project report should be prepared as per the guidelines issued by the University of Mumbai. Along with project report a CD containing: project documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and where as internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project.

Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical :

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-II.

AC 14/7/2016
Item No. 4.25

UNIVERSITY OF MUMBAI

Revised Syllabus

For

Master of Engineering

Program: M. E. (Computer Engineering)

Under

FACULTY OF TECHNOLOGY

(As per Choice Based Credit and Grading System)

from

Academic Year 2016-17

From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The M. E. in Computer Engineering programme is offered to students who are interested in advanced learning and research in any area of Computer Science and Engineering. Applicants to this programme are expected to have a background in Computer Science and Engineering or Information Technology.

The objective of the programme is to enable the learner to apply his/her enhanced skill and knowledge at the top research laboratories and companies in the country and even abroad.

The programme is a 72-credit degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

University of Mumbai feels that it is desirable to provide specialized ME programme in Computer Engineering to address the needs of the industry, which today requires more specialized resource in each field.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Subhash K. Shinde

Chairperson,

Adhoc Board of Studies in Computer Engineering,

University of Mumbai, Mumbai.

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai)

Semester –I

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	Algorithm & Complexity	04	---	---	04	---	---	04
CSC102	Advance Computer Network and Design	04	---	---	04	---	---	04
CSC103	Advanced Operating Systems	04	---	---	04	---	---	04
CSDLO-I	Department Level Optional Course-I	04	---	---	04	---	---	04
ILO-I	Institute Level Optional Course-I	03	---	---	03	---	---	03
CSL101	Computational Laboratory-I	--	02	--	01	---	--	01
CSL102	DEC Laboratory-I	--	02	--	01	---	--	01
Total		19	04	--	21	--	--	21

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC101	Algorithm & Complexity	20	20	20	80	3	--	---	100
CSC102	Advance Computer Network and Design	20	20	20	80	3	--	---	100
CSC103	Advanced Operating Systems	20	20	20	80	3	--	---	100
CSDLO-I	Department Level Optional Course-I	20	20	20	80	3	--	---	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	---	100
CSL101	Computational Laboratory-I	---	---	---	----	----	25	25	50
CSL102	DEC Laboratory-I	---	---	---	----	----	25	25	50
Total		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai)

Semester –I

Course Code	Department Level Optional Course-I	Course Code	Institute Level Optional Course-I
CSDLO1011	Logic & Automated Reasoning	ILO1011	Product Lifecycle Management
CSDLO1012	Image Analysis & Interpretation	ILO1012	Reliability Engineering
CSDLO1013	Natural Language Processing	ILO1013	Management Information System
CSDLO1014	Computational Intelligence	ILO1014	Design of Experiments
CSDLO1015	User Experience Design	ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management & Mitigation Measures
		ILO1018	Energy Audit and Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS201	High performance Computing	04	---	---	04	---	---	04
CS202	Data Science	04	---	---	04	---	---	04
CS203	Ethical Hacking and Digital Forensics	04	---	---	04	---	---	04
CSDLO-II	Department Level Optional Course –II	04	---	---	04	---	---	04
ILO-II	Institute Level Optional Course-II	03	---	---	03	---	---	03
CSL201	Computational Laboratory-II	--	02	--	01	---	--	01
CSL202	DEC Laboratory-II	--	02	--	01	---	--	01
Total		19	04	---	21	--	--	21

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC201	High performance Computing	20	20	20	80	3	--	---	100
CSC202	Data Science	20	20	20	80	3	--	---	100
CSC203	Ethical Hacking and Digital Forensics	20	20	20	80	3	--	---	100
CSDLO-II	Department Level Optional Course –II	20	20	20	80	3	--	---	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	--	---	100
CSL201	Computational Laboratory-II	---	---	---	---	----	25	25	50
CSL202	DEC Laboratory-II	---	---	---	---	----	25	25	50
		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	Department Level Optional Course -II	Course Code	Institute Level Optional Course-II
CSDLO2021	Data Storage & Retrieval	ILO2021	Project Management
CSDLO2022	Internet of Things	ILO2022	Finance Management
CSDLO2023	Advance Soft Computing	ILO2023	Entrepreneurship Development and Management
CSDLO2024	Semantic Web & Social Network Analysis	ILO2024	Human Resource Management
CSDLO2025	ICT for Social cause	ILO2025	Professional Ethics and CSR
		ILO 2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS301	Special Topic Seminar	----	06	--	---	03	--	03
CS302	Dissertation-I	---	24	--	---	12	--	12
Total		**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
CS302	Dissertation-I	---	---	---	---	---	100	---	100
Total		---	---	---	----	---	**150**	**50**	**200**

Semester –IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS401	Dissertation-II	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
CS401	Dissertation-II	--	---	---	---	---	100	100	200
Total		**--**	**---**	**---**	**---**	**---**	**100**	**100**	**200**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	Algorithm and Complexity	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To analyze the algorithms using space and time complexity.
2. To teach problem formulation and problem solving skills.
3. To acquire knowledge of various applied algorithms.
4. To understand selected topics in algorithms that have found applications in areas such as geometric modelling, graphics, robotics, vision, computer animation, etc.

Course Outcomes: At the end of the course student should be

- Able to prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains
- Able to apply the algorithms and design techniques to solve problems.

Prerequisite: Data structure, Analysis of Algorithms, Set Theory

Sr. No.	Module	Detailed Content	Hours
1	Foundations	• Algorithms, Analysing algorithms, Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis • Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms	4
2	Advanced Design and Analysis Techniques	• Dynamic Programming-Elements of dynamic programming, Matrix-chain multiplication • Greedy Algorithms-Elements of the greedy strategy, Huffman codes • Amortized Analysis-Aggregate analysis, The accounting method, The potential method, Dynamic tables	6

3	Graph Algorithms	• Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra's algorithm, Difference constraints and shortest paths • All-Pairs Shortest Paths-The Floyd-Warshall algorithm • Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching	8
4	Computational Geometry	• Line-segment properties, Determining whether any pair of segments intersects, • Finding the convex hull, Finding the closest pair of points	8
5	NPC and Approximation Algorithms	• NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems, • Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, The subset-sum problem	10
6	Applied Algorithms	• Number-Theoretic : Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA • String Matching Algorithms :The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Longest common subsequence • Parallel Algorithm: Mesh Algorithm and its applications • Probabilistic Algorithm: Game Theoretic Techniques • Randomized Algorithms: Monte Corlo and Las Vegas algorithms	12

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition
2. Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms", Galgotia
3. Rajeev Motwani, PrabhakarRaghavan, " Randomized Algorithm", Cambridge University Press

Reference Books:

1. Aho, Hopcroft, Ullman: The Design and analysis of algorithms", Pearson Education
2. Vijay V. Vajirani, "Approximation Algorithms",Springer.

3. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI
4. SanjoyDasgupta, Christos Papadimitriou, UmeshVazirani, “Algorithms”, Tata McGraw-Hill Edition

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC102	Advanced Computer Networking and Design	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	Term Work	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To study the problem of congestion control and service integration in TCP/IP networks focusing on protocol design, implementation and performance issues.
2. To understand the principles of network design and enable students to setup, configure and interconnect an IP network.
3. To debate the current trends and leading research in the computer networking area.

Course Outcomes: Learner will able to

- Understand the theoretical issues in protocol design and apply it to Quality of service in networks.
- Understand issues in the design of network processors and apply them to design network systems
- Simulate working of wired and wireless networks to understand networking concepts.
- Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
- Understand the basics of software defined networking and explore research problems in that area.

Sr. No.	Module	Detailed content	Hours
1	**Internetworking**	**Congestion control and Resource allocation**: Issues of Resource Allocation, Queuing Disciplines: FIFO, Fair Queuing, TCP Congestion Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery. **Congestion-Avoidance Mechanisms**: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF).	10

2	**Routing:**	IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing.	08
3	**IPv6**	IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols.	06
4	**Network Design:**	Designing the network topology and solutions-Top down Approach: PPDIOO – Network Design Layers - Access Layer, Distribution Layer, Core/Backbone Layer, Access Layer Design, Backbone Network Design, Enterprise LAN Design: Ethernet Design Rules and Campus Design best practices, Virtualisation and Data Center Design, Wireless LAN Design, WAN Design: Traditional WAN Technologies, VPN Design.	14
5	**Ad Hoc Wireless Networks**	MAC Protocols for Ad Hoc Wireless Networks: MACA/W, MACA-BI, DPRMA, MACA/PR. Routing Protocols for Ad Hoc Wireless Networks: DSDV, DSR, AODV, ZRP. Transport Layer: ATCP.	06
6	**Software Defined Networking and OpenFlow**	Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	04

Text Books:

1. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Elsevier, Fourth Edition.
2. Philip M. Miller, *TCP / IP: The Ultimate Protocol Guide Applications, Access and Data Security - Vol 2, Wiley*
3. Pete Loshin, IPv6: Theory, Protocols and Practice, Morgan Kaufmann, 2nd Edition, 2004
4. Anthony Bruno, Steve Jordan, Official Cert Guide: CCDA, Cisco Press,
5. C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and, Prentice Hall, 2004.
6. Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013

Reference Books:

1. William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.
2. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Third Edition, Addison Wesley, 2004.
3. Pujolle, Software Networks: Virtualisation, SDN, 5G, Security, Wiley,

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC103	Advanced Operating System	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To learn the architectural differences and issues related to Advanced Operating System.
2. To get a comprehensive knowledge of the distributed systems and Real time operating system.
3. To get a thorough knowledge of database operating systems and cloud operating System.

Course Outcomes: Learner will able to

- Apply the principles and concepts in analyzing and designing Advance Operating System.
- Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
- Analyze the performance and reliability of different Advanced Operating Systems.

Sr. No.	Module	Detailed content	Hours
1	Introduction	• Types of Advanced Operating Systems. • Architectures and design issues of Network operating system, DOS, Middleware, RTS, DBOS. • Introduction to process, Concurrent processes, Critical Section problems, other synchronization problems.	04
2	Distributed operating Systems, Scheduling and synchronization	• Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, Selecting a suitable load sharing Algorithm. • Synchronization: Physical and logical clocks. • Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms. • Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and	12

		resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.	
3	Distributed Fault Handling	• Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem. • Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery. • Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocols.	10
4	Real Time Operating Systems	• Types of Real time tasks, Timing Constraints, Modeling Timing Constraints. • Task Scheduling: Types of tasks and their characteristics, Task Scheduling, Clock driven Scheduling , Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm • Resource Handling: Resource Sharing, Priority Inversion, PIP,PCP,HLP. • Scheduling real time tasks in distributed systems	12
5	Database Operating systems	• Concurrency control : Database systems, Concurrency control model of database systems, Problem of Concurrency Control, serializability theory, Distributed Database Systems • Concurrency Control Algorithms : Basic synchronization Algorithms, Lock based, Timestamp based and Optimistic Algorithms, Concurrency Control Algorithms : Data Replication	06
6	Case Study	• DOS: Mach, Amoeba • .RTOS : UNIX as RTOS , Windows as RTOS. • Mobile OS. • Cloud OS	04

Text books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems" .MC Graw Hill education.
2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson education.

Reference Books:

1. Andrew S.Tanenbaum, "Modern Systems Principles and Paradigms". PHI.
2. Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
3. Andrew S.Tanenbaum, "Distributed Operating System", Pearson Education.
4. Jane W. S. Liu, “Real Time Systems”, Pearson education.

The suggested lists of experiment/case study of Advanced Operating System are as follows:

I. Flexibility/Load Distribution

1) Implement and study the incremental/decremented growth of response and service times for different number of client and servers for servicing continuous stream(s) of constant sized messages.
2) Implement a name server for registration and identification of services running on another server. The client contacts the name server for a particular service and the service request is forwarded to the specific server registered on the name server. Study the load distribution for different number of service servers, clients and service requests.

II. Fault Tolerance/Reliability

1) Implement a fault tolerant client and server application using the concept of name server. The client incorporates fault tolerant by sending a service request to another server using name server, if the current server fails to respond within 10 seconds.
2) Implement a stateful server for a transaction consisting of mainly four operations viz. open a file, close opened file, read from opened file and write to opened file. The state of file operation is maintained at stateful server.

III. Performance

1) Implement a client-server application for a computing problem (of exponential complexity). Compare the performance for a local and remote machine of different speeds.
2) Implement parallel Fast-Fourier-Transform (parallel FFT). Show that the overall communication time complexity is O ((n/p) log p), and the computational complexity of the parallel algorithm is O (n log n/p) where n is number of elements, and p is number of processes.

IV. Transparency

1) Implement a client-server application to show transparent service access so that the client does not know the location of service is being executed.

V. Mobile Application

1) Implement a client-server application to allow transfer of any data (e.g. images, documents, videos etc.) on android mobile operating system. Each mobile device runs a program which acts as a server when it receives data from another device or a client when it sends data to another mobile device.
2) Implement a distributed share list among a group of mobile device users which is similar to Google document.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1011	Logic & Automated Reasoning	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Represent mathematical and other knowledge using logical formalism.
2. Understand theoretical concepts and results that form the basis of current automated reasoning systems.
3. Understand advanced techniques of resolution theorem proving and be able to use them.

Outcomes: Learner will be able to ...

- Comprehend syntax and semantics of Propositional logic, first-order logic, inference system, proof, soundness and completeness.
- Apply various deductive algorithms and models for reasoning
- Emphasize various techniques for automated reasoning, theorem proving

Sr. No.	Module	Detailed Contents	Hours
1	Introduction to Logic	• Mathematical Logic, Propositional Logic, First-Order Logic, Modal Logic, Temporal Logic, • Program Verification	04
2	Propositional Logic	• Formulas, Models, Tableaux: Propositional Formulas, Interpretations ,Logical Equivalence, Sets of Boolean Operators, Satisfiability, Validity and Consequence, Semantic Tableaux, Soundness and Completeness • Resolutions: Conjunctive Normal Form, Clausal Form, Resolution Rule, Soundness and Completeness of Resolution • Binary Decision Diagrams: Motivation Through Truth Tables, Definition of Binary Decision Diagrams, Reduced Binary Decision Diagrams	12
3	First-Order Logic	• Formulas, Models, Tableaux: Relations and Predicates, Formulas in First-Order Logic, Interpretations, Logical Equivalence, Semantic Tableaux, Soundness and Completion of Semantic Tableaux • Resolution: Ground Resolution, Substitution, Unification, General Resolution, Soundness and	12

		Completeness of General Resolution • Introduction to Logic Programming: Prolog	
4	Reasoning Methods	• SAT Solvers: Properties of Clausal Form, • Davis-Putnam Algorithm, DPLL Algorithm • Deductive Systems: Gentzen System, Hilbert System • Terms and Normal Forms : First-Order Logic with Functions, PCNF and Clausal Form, Herbrand Models	08
5	Automated Reasoning	• Automated Reasoning for Web system, • Semantic Web applications, • REWERSE-automated reasoning method and tools,	06
6	Theorem Proving	• Some exposure to theorem proving systems such as Prolog, PVS, SPIN	06

Text Books

1. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer
2 Arindama Singh, Logics for Computer Science, Prentice Hall of India.

Reference Books

1. Handbook of Practical Logic and Automated Reasoning, John Harrison, Cambridge University Press
2. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Note: One Case Study to be given for Module 5 and 6 based on the above concepts.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1012	Image Analysis and Interpretation	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Objective:

1. To explore the various Image Analysis and Interpretation techniques
2. To become accustomed with different methods of Feature generation, Representation Description and Interpretation.
3. To Analyze & Interpret Images and use for various applications

Outcome: Learner will able to

- Understand the importance of Image Analysis and Interpretation.
- Analyze various methods of Image Analysis
- Use the methods of image analysis and interpretation for various Image Processing applications.

Prerequisite: Image Processing, Mathematics**.**

Sr. No.	Module	Detailed content	Hours
1	Introduction to Image Processing System	• Introduction, • Sources of Images • Classification of Images • Elements of Image Processing System • Image Modelling – Sampling, Quantization and Representing Digital Images. • Image Preprocessing – o Enhancement : Power Law Transformation, Contrast Stretching and Histogram Equalization o Spatial domain Filters: Smoothing, Sharpening	08

2	Feature Generation	• Introduction • Basis Vectors and Images • K-L transformation • Singular Value Decomposition • Independent Component Analysis • Non–Negative Matrix Factorization • Non- linear Dimension Reduction • Haar Transform • Multi resolution Interpretation	12
3	Image Analysis	• Data Structure for Image Analysis o Levels of image data representation o Traditional image data structures o Hierarchical data structures • Image Segmentation o Thresholding o Edge based and Region Based Segmentation o Boundary Extraction • Feature Extraction o Spatial Feature Extraction o Transform Feature Extraction	10
4	Image Representation and Description	• Boundary Representation • Region Representation • Moments Representation • Structure Representation • Shape Representation • Texture Representation	06 .
5	Statistical decision making and Vector Quantization	• Statistical decision making: Bayesian theorem Multiple features Conditionally independent features Decision boundaries Unequal cost of error Estimation of error rates • Vector Quantization	08
6	Applications	Case Study on • Remote Sensing Images • Medical Images • Image Forensics: Finger print classification • Digital Watermarking for Images	04

Text Books:

1. Fundamentals of Digital Image Processing Anil K. Jain, PHI
2. Pattern Recognition, Theodoridis & Koutroumbas, 4th Edition, Academic Press
3. Digital Image Processing ,Second Edition, Rafael C. Gonzalez and Richard E.Woods, Pearson Prentice Hall,
4. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar,Tata McGraw-Hill Education Private Limited, 2011.
5. Digital Image Processing, S. Sridhar, Oxford University Press.
6. Image Processing, Analysis, and Machine Vision, Milan Sonka Vaclav Hlavac Roger Boyle.
7. Pattern recognition and Image analysis by Earl Gose, Richard Johnsonbaugh, Steve Jost, PHI publication

Reference Books:

1. Digital Image Processing An Algorithm Approach, Madhuri A. Joshi, PHI
2. Principles of Soft Computing , S N Shivanandan, S N Deepa, Wiley

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1013	Natural Language Processing	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To formulate the problems and solutions of NLP and establish their relation to linguistics and statistics.
2. To implement various language Models.
3. To design systems that uses NLP techniques
4. To train and evaluate empirical NLP systems.

Course Outcomes: At the end of the course student should be able to

- Model linguistic phenomena with formal grammars.
- Design, implement, and analyze NLP algorithms
- Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction...etc.
- Implement proper experimental methodology for training and evaluating empirical NLP systems.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP- Machine translation, question answering system, Information retrieval, Text categorization , text summarization & Sentiment Analysis	3
2	**Word Level Analysis**	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology; Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST - Porter stemmer. N –Grams- N-gram language model , N-gram for spelling correction .	9

3	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, class based n –grams .Context Free Grammar – Constituency , Context free rules & trees, Sentence level construction , Noun Phrase, coordination, agreement, the verb phrase & sub categorization	10
4	**Semantic Analysis**	Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Wordnet, Selectional restriction based disambiguation & limitations , Robust WSD – machine learning approach and dictionary based approach	10
5	**Pragmatics**	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference, preferences in pronoun interpretation , algorithm for pronoun resolution .Text coherence, discourse structure	8
6	**Applications (preferably for Indian regional languages)**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis.	8

Text Books:

1. Daniel Jurafsky, James H. Martin “Speech and Language Processing” Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, “ Foundations of Statistical Natural Language Processing “, MIT Press, 1999.

Reference Books :

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni “ Multilingual natural language processing applications” Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) “ The Handbook of Computational Linguistics and Natural Language Processing “ ISBN: 978-1-118-

Case study/Experiments:

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: **http://cse24-iiith.virtual-labs.ac.in/#**

Sample Case study/Experiments:

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Word Analysis
2. Word generation
3. Stop word removal
4. Stemming
5. Morphology
6. POS Tagging
7. Chunking
8. N-gram language model

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1014	Computational Intelligence	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To explore the various computational Intelligence techniques
2. To become familiarized with Neural Network, Fuzzy logic & evolutionary techniques
3. To learn to apply computational Intelligence to different applications

Course Outcomes: Learner will able to

- Understand the importance of computational Intelligence.
- Analyze various computational Intelligence technology
- Design and implement various intelligent system.

Prerequisite: Soft Computing, Mathematics

Sr. No.	Module	Detailed content	Hours
1	Introduction to Computational Intelligence paradigms	Artificial Neural Networks, Fuzzy Systems, Genetic Algorithms, Swarm Intelligence, Artificial Immune System, Applications	6
2	Artificial Neural Networks & SVM	Basic models of ANN: NN Architecture, MP Neuron, Linear separability, activation functions, types of learning Learning Rules: Hebbian, Perceptron, Delta, Winner-take all Supervised NN: Perceptron Network: SDPTA, SCPTA, MCPTA, Adaline networks Support Vector Machine: Binary SVM	14
3	Fuzzy Systems	Fuzzy Sets: Definition, operations, properties, relations, characteristics, membership functions, defuzzification.	8
4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples.	10

		Swarm Intelligence: Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social-Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO, Ant Algorithm: Simple Ant Colony Optimization	
5	Artificial Immune System	Natural Immune System: Classical view, Antibodies and antigens, Artificial Immune Models: Artificial Immune system algorithm, classical view models, CLONALG	4
6	Applications	Character Recognition, Genetics Algorithm in game playing, Color Recipe prediction- Single MLP approach ANT algorithm/Swarm Intelligence – TSP, Best path finding	6

Text Books:

1. Computational Intelligence An Introduction, Andries P. Engelbrecht, Wiley, 2nd Edition
2. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Wiley, 2nd edition
3. Introduction to Artificial Neural Systems, Jacek M. Zurada, West Publication
4. Pattern Recognition, Theodoridis and Koutroumbas , 4th Edition, Academic Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO1015	User Experience Design	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To study and understand importance of user experience design principles
2. To understand elements of user experience design
3. To encourage students to participate in designing futuristic applications

Course Outcomes: Learner will be able to:

- To Apply principles of user experience
- To apply emerging and established technologies to enhance User Experience design
- To create interface for international standards with ethics
- To evaluate user experience.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc. User experience design is concerned with all the elements that together make up user interface, including layout, visual design, text, brand, sound, and interaction. User Experience Design works to coordinate these elements to allow for the best possible interaction by users.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction	Introduction to interface design, Understanding and conceptualizing Interface, Understandinguser's conceptual cognition.	04
2	Elements of UX Design	Core Elements of User Experience, Working of UX elements	04
3	The UX Design Process – Understanding Users	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.	08
4	The UX Design Process- The Structure: Information Architecture and Interaction Design	Visual Design Principles ,Information Design and Data Visualization Interaction Design ,Information Architecture , Wire framing & Storyboarding,UI Elements and Widgets, Screen Design and Layouts	08

5	UX Design Process: Prototype and Test	Testing your Design, Usability Testing,Types of Usability Testing ,Usability Testing Process, Preparing and planning for the Usability Tests, Prototype your Design to Test, Introduction of prototyping tools,conducting Usability Test, communicating Usability Test Results	08
6	UX Design Process: Iterate/ Improve and Deliver	Understanding the Usability Test,findings, Applying the Usability Test, feedback in improving the design. Communication with implementation team. UX Deliverables to be given to implementation team	04

Text Books

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin
3. Designing The user Interface by Shneiderman, Plaisant,Cohen,Jacobs Pearson

Reference Books:

1. The Elements of User Experience by Jesse James Garrett
2. Don't make me think, by Steve Krug
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credits
ILO 1011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system,	05

	financial justification of PDM, barriers to PDM implementation	
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 1012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 1013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE).
2. To list the guidelines for designing experiments.
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, “Taguchi Technique for Quality Engineering,” McGraw Hill.
7. Madhav S Phadake, “Quality Engineering using Robust Design,” Prentice Hall.

Course Code	Course Name	Credits
ILO 1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO 1016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 1017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06

04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 1018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction	10

	motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com ; www.bee-india.nic.in

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSL101</td><td rowspan="6">Computational Laboratory-I</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td colspan="2" rowspan="3">Pract / Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>---</td><td>---</td><td>---</td><td>---</td><td>25</td><td colspan="2">25</td></tr>
</table>

Module	Detailed Content	Lab Session
Algorithm and Complexity	• Implementation of algorithms which demonstrate greedy strategy, dynamic programming, Flow network, parallel algorithm and string matching (any two).	02
Networking Design	• Install tool CISCO Packet Tracer Student Edition (open-source). Explore this tool and use it to design an Internetwork using switches, routers and the concept of VLAN. Configure different routing protocols like RIP, OSPF, EIGRP etc. on the network you have designed and observe the performance. Test your network using "ping" and "show ip route". • Install mininet (open-source). Create virtual architecture for SDN openvswitch(s), host(s), controllers(s) and test various topologies using basic commands like ping. Optionally connect mininet openvswitch with external controllers like open day light (open-source).	05
Advanced Operating System	• The Advanced Operating System laboratory work should clarify the basic concepts of **Flexibility / Load Distribution** (system scales easily to accommodate increase in number of machines with corresponding increase in performance), **performance** (running an application should not be appreciably worse than running it on a single CPU system), **reliability** (system should be available and functional in presence of failures) and **transparency** (system should provide a single system image). • Every student should perform at least two experiments from above categories (i.e. Flexibility/Load Distribution, Fault Tolerance/Reliability, Performance, Transparency and Mobile Application) using C / C++ programming language.	05

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

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<tr><td rowspan="6">CSL102</td><td rowspan="6">DEC Laboratory-I</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
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</table>

Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC201	High Performance Computing	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	Term Work	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms

Course Outcomes: Learner will be able to:

- Understand different parallel processing approaches and platforms involved in achieving High Performance Computing.
- Understand design Issues and limitations in Parallel Computing.
- Learn to programming using message passing paradigm using open source APIs, design algorithms suited for Multicore processor and GPU systems using OpenCL, OpenMP.
- Analyze and optimize performance parameters.
- Understand HPC enabled Advanced Technologies.

Sr.No	Module	Detailed Content	Hours
1	Parallel Processing approaches	**Introduction to Parallel Processing:** Levels of Parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation etc.). Loosely coupled and Tightly coupled **HPC Platforms:** Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, hybrid (MPI/OpenMP) programs, Grid Computing, Cloud Computing , Multi-Core Processors, accelerators, GPGPUs	06
2	Design Issues and limitations in Parallel Computing	Parallel Architecture, (Interconnection network, processor Array, Multiprocessor) Designing Parallel algorithms (Partitioning, Communication, Mapping, Matrix input/output)	10

		Issues: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures **Limitations:** Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	
3	Programming using message passing paradigm	Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing	10
4	Parallel Programming using GPGPU	An Overview of GPGPUs, An Overview of GPGPU Programming, An Overview of GPGPU Memory Hierarchy Features, Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL	12
5	Performance Measures	Performance measures: Speedup, efficiency and scalability. Abstract performance metrics (work, critical paths), Amdahl`s Law, Gustavson's law, weak vs. strong scaling, performance bottlenecks, data races and determinism, data race avoidance (immutability, futures, accumulators, dataflow), deadlock avoidance, abstract vs. real performance (granularity, scalability)	06
6	HPC enabled Advanced Technologies	Nanotechnology and its impact on high performance computing, Power aware processing techniques in high performance computing. Case studies on high performance computing	04

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang,Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill,Second Edition, 2010.

3. Edward Kandrot and Jason Sanders, “CUDA by Example – An Introduction to General Purpose GPU Programming”,Addison-Wesley Professional ©, 2010.
4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, “Heterogeneous Computing with OpenCL”, Elsevier, Second Edition, 2013.

Reference Books:

1. Georg Hager, Gerhard Wellein, “Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
2. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill International Editions, Computer Science Series, 2008.
3. Kai Hwang, Zhiwei Xu,“Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw Hill, 1998.
4. Laurence T. Yang, MinyiGuo, “High- Performance Computing: Paradigm and Infrastructure” Wiley, 2006.

List of Experiments to be included in Computational Lab II

Solve given problems using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.

1. Matrix-Matrix multiplication – simple/Cannon’s/ DNS algorithm
2. Sorting – Bitonic/Shell sort/Quicksort/Bucket/ Radix
3. All-pairs shortest paths – Dijkstra’s algorithm/Floyd’s algorithm

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC202	Data Science	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To understand the foundations of the Data Science process, methods and techniques
2. To represent and organise knowledge about large heterogeneous data collections
3. To use mathematical models and tools for large-scale data analysis and reasoning
4. To work and evaluate Data at Scale – Working with Big Data

Course Outcome: Learner will able

- Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
- Apply statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.
- Design, implement, and evaluate the core algorithms underlying an end-to-end data science workflow, analysis, and visualization of information derived from large datasets.
- Apply “best practices" in data science with modern tools

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Data Science	Data science process: Defining goal, retrieving data, preprocessing data, exploratory data analysis, model building and data visualization, Ethical issues in data science. Probability: review of probability theory, normal distribution, Gaussian discriminant analysis: Linear discriminant analysis (LDA), Logistic regression: Bayesian logistic regression,	08
2	Predictive and Descriptive Models	Descriptive Modeling: Principal components analysis (PCA), singular value decomposition (SVD), probabilistic PCA, applying PCA to new data, PCA for data interpretation., EM algorithm for PCA, Independent Component Analysis (ICA), Maximum likelihood estimation using EM. Predictive Modeling: Predictive modeling process,	12

		supervised and unsupervised learning, parametric and non-parametric models, business intelligence, challenges in using predictive analytics Introduction to time series analysis and time series mining, Introduction to spatio-temporal data, spatio-temporal model, fast dynamic time warping.	
3	Evaluation and Methodology of Data Science	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression Interpretation of results: Confidence interval for accuracy, hypothesis tests for comparing models, algorithms.	03
4	Text Analytics and Recommendation system (RS)	Introducing text mining, text mining techniques, Understanding Text Mining Process, Sentiment Analysis. Introduction to RS, content based RS, collaborative RS, hybrid RS. Issues and challenges RS, examples of real word RS, e.g., Amazon, mobile RS, etc.	08
5	Data Communication and Information Visualization	Data Communication: cost Function, how to Minimize cost function, coefficients of determination. Information visualization: effective information visualization, visual Encodings, perception of visual cues, data scales, visualizing time series data, data journalism, dashboards.	08
6	Scaling with Big Data	Introduction of big data, characteristics of big data, data in the warehouse and data in Hadoop, Importance of Big data, Big data Use cases: patterns for Big data deployment, MapReduce and Hadoop Ecosystem architecture, NoSQL,analyzing data with Pig and R.Sharding, indexing large-scale data, sampling, data leakage, data incest.	09

Reference Books:

1. Davy Cielen,Meysman,Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Paul C. Zikopoulos, Chris Eaton, Dirk deRoos, Thomas Deutsch and George Lapis, “Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data”, The McGraw Hill Companies, 2012

4. Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
5. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
6. Seema Acharya and SubhashiniChellappan, “Big Data and Analytics”, Wiley
7. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
8. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
9. EMC Education Services,”Data Science and Big Data Analytics”,Wiley
10. DT Editorial Services, “Big Data Black Book”, Dreamtech Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC203	Ethical Hacking and Digital Forensics	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. To understand underlying principles and many of the techniques associated with the digital forensic practices.
2. To explore practical knowledge about ethical hacking Methodology.
3. To develop an excellent understanding of current cyber security issues and ways that user, administrator and programmer errors can lead to exploitable in securities.

Course Outcomes: Learner will able to

- Understand the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
- Acquire knowledge of various digital forensic tools and ethical hacking.
- Interpret security issues in ICT world, and apply digital forensic tools for security and investigations.
- Achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system, mobile, email etc.
- Generate legal evidences and supporting investigation reports.

Sr. No.	Module	Detailed content	Hours
1	Ethical Hacking Methodology	Introduction, Steps of Ethical Hacking: Planning, Reconnaissance, Scanning, Exploitation, post exploitation and result reporting. Ethical Hacking Tool: Metasploit	6Hrs
2	Introduction to Digital Forensics	The Need for Digital Forensics, Types of Digital Forensics, Introduction to Incident Response Methodology, Incident handling steps, Ethics in Digital Forensics.	6 Hrs
3	Data Collection	Live Data Collection from Windows and Unix Systems, Tools for Forensic Duplication, Collecting Network-based Evidence, Evidence Handling - Chain of Custody. Data Collection Forensic Tools : Forensics Toolkit/ WinHex	14 Hrs
4	Data Analysis	Data Analysis, Investigating Windows, Unix Systems, Analysing Network Traffic, Investigating Routers, Email forensics	12 Hrs

		Data Analysis Tools : Nmap/Wireshark/Helix3pro	
5	Mobile Device Forensics	Crime and mobile phones, evidences, forensic procedures, files present in SIM cards, device data, external memory dump, and evidences in memory card, operator's networks.	6 Hrs
6	Forensic Investigation Reporting	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	4 Hrs

Text Books:

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing, Second Edition: Ethical Hacking and Penetration Testing Made Easy", 2nd Edition, Syngress.
3. Investigation Procedures and Response**,** EC-Council Press.

Reference Books:

1. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999.
2. Debra Littlejohn Shinder and Ed Tittel, "Scene of the Cybercrime: Computer Forensics Handbook", Syngress Publishing, Inc.
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools andTechnology", Academic Press, 1st Edition, 2001
4. Nina Godbole, "Information Systems Security", Wiley India, New Delhi
5. William Stallings, "Cryptography and Network Security", Pearson Publication

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2021	Data Storage and Retrieval	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Understand need of storage network with its architecture, features, components, topology, benefits and limitations.
2. Study the impact of downtime in terms of losses and business continuity.
3. Understand the basic terminologies and components in information retrieval systems.
4. Compare and contrast Information Retrieval models.

Course Outcomes: Learner will able to…

- Evaluate storage architecture, ISS, SAN, NAS and IP SAN.
- Design the storage infrastructure for business continuity.
- Implement and evaluate various Information Retrieval Models.

Sr. No.	Modules	Detailed content	Hours
1	Introduction to Data Storage	Need for storage network, Evolution of storage technology and architecture, Key Challenges in managing information, Information lifecycle, Disk drive performance, Fundamental laws governing disk performance.	04
2	Storage System Environment	Basic Software for Storage Networking: Software for SANs, Shared access data managers, Volumes(RAID): Resilience, performance and flexibility, File systems and application performance. Intelligent Storage System:Storage Virtualization: Form of Virtualization, storage virtualization configurations and challenges, Types of storage virtualization. Content-Addressed Storage: Architecture, Object storage and Retrieval in CAS.	08
3	Storage Networking	Storage Area Networks: Fibre Channel, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel	12

	Technologies	Architecture, Zoning, Fibre Channel Login Types, FC Topologies. Network-Attached Storage: General-Purpose Servers vs. NAS Devices, Benefits of NAS, NAS File I/O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. IP SAN: iSCSI, FCIP.	
4	Business Continuity and Enterprise backup	Introduction to Business Continuity: Information availability, BC planning lifecycle, Failure Analysis, Business impact analysis. Enterprise backup software for SAN: Backup management, Enterprise data protection, Backup architecture, Backup policies, Minimizing impact of backup, Lan-free and serverless backup.	06
5	Information Retrieval	Introduction to Information Retrieval(IR), Objectives and Components of IR system, Taxonomy of IR models, Information Retrieval process, Documents and Query forms	06
6	Retrieval Models	Query structure, The matching process, Text analysis	10

Text Books:

1. G. Somasundaram, Alok Shrivastava, "Information Storage and Management", EMC Education services", Wiley Publication, Edition 2009
2. Richard Barker, Paul Massiglia, "Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs", Wiley India
3. Robert R. Korfhage, "Information Storage and Retrieval", Wiley Publication

Reference Books:

1. Ulf Troppens,Wolfgang Muller-Friedt,Rainer Wolafka, "Storage Networks Explained" Wiley Publication
2. Spalding, Robert. Storage Networks: The Complete Reference. Tata McGraw-Hill Education, 2003

3. Manning, Christopher D., Prabhakar Raghavan, and Hinrich Schütze. Introduction to information retrieval. Vol. 1, no. 1. Cambridge: Cambridge university press, 2008.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2022	Internet of Things	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:

1. Provide an overview of concepts, main trends and challenges of Internet of Things.
2. Develop the ability to use Internet of Things related software and hardware technologies.
3. Provide the knowledge of data management business processes and analytics of IoT.
4. Develop skills to relate the IoT technologies for practical IoT applications such as smart objects.

Course Outcomes: Learner will able to -

- Explain and interpret the Internet of Things concepts and challenges.
- Experiment with the software and hardware IoT Technologies.
- Understand data management and business processes and analytics of IoT
- Design and develop small IoT applications to create smart objects

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Internet of Things	IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects.	8
2	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Interfacing.	8
3	IoT Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others.	8

4	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT.	4
5	Data Management, Business Process and Analytics	Data Management, Business Process in IoT, IoT Analytics, Creative Thinking Techniques, Modification, Combination Scenarios, Decentralized and Interoperable Approaches, Object – Information Distribution Architecture, Object Naming Service (ONS), Service Oriented Architecture, Network of Information, Etc.	12
6	Application and Use Cases	Concrete Applications and Use – Cases of Web Enabled Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. M2M, Industrial IoT Applications.	8

Text Books:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi ,Wiley .
3. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

1. The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.
2. IoT –From Research and Innovation to Market development, River Publication by Ovidiu Vermesan and Peter Friess.
3. Building Internet of Things with Arduino by Charalampos Doukas.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2023	Advanced Soft Computing	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

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Course Objectives:

1. To familiarize various soft computing techniques.
2. To relate various soft computing techniques in practical scenario.
3. To understand hybrid approach for application development.

Course Outcomes: At the end of the course, the learner will be able to-

- To demonstrate various soft computing techniques.
- To apply and analyze different soft computing techniques for solving practical applications.
- To design an intelligent system for social and technical problems.

Pre-requisite: Basic mathematics, soft computing, Computational intelligence

Sr. No.	Module	Detailed content	Hours
1	Introduction	Differentiate Hard and Soft Computing, Soft Computing Constituents, Neuro Fuzzy and Soft Computing Characteristics	2
2	Fuzzy Logic & Rough Set Theory	Fuzzy Relations and Fuzzy Rules, Generalized Modens Ponens, Defuzzification and its Types Fuzzy Inference Systems, Design of Fuzzy Controller, Introduction to Rough Sets	12
3	Supervised Network	Error Back Propagation Training Algorithm, Radial Basis Function	10
4	Unsupervised Network	Kohenon Self Organizing Maps, Basic Learning Vector Quantization, Basic Adaptive Resonance Theory	12

5	Hybrid Systems and Introduction to Deep Learning	Fuzzy-Neural Systems, Neuro-Genetic Systems Fuzzy-Genetic Systems, Deep Learning : Definition & background, historical context of deep learning, Three classes of deep learning network.	8
6	Applications and Case Study	Automobile Fuel Efficiency using ANFIS Color Receipe prediction using CANFIS	4

Text Books

1. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
2. S. Rajasekaran and G.A. Vijaylakshmi Pai.. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
4. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
5. Samir Roy, Udit Chakraborty "Introduction to Soft Computing" Pearson Education India.
6. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.
7. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.

Reference Books:

1. Fakhreddine O. Karry, Clarence De Silva," Soft Computing and Intelligent systems Design Theory, Tools and Applications" Pearson 2009.
2. Li Deng and Dong Yu , 'Deep Learning Methods and Applications'.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2024	Semantic Web & Social Network Analysis	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam	Term Work	Pract	Oral
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Semantic Web provide a graph model (RDF), a query language (SPARQL) and schema definition frameworks(RDFS and OWL) to represent and exchange knowledge online. These technologies provide a whole new way of capturing social networks in much richer structures. Social network Analysis(SNA) tries to understand and exploit the key features of social networks in order to manage their life cycle and predict their evolution. Objective of the course is to understand how to facilitate and enhance the analysis of online social networks, exploiting the power of semantic web technologies.

Course Objectives (CEO):

1. To understand the basics of Semantic Web Technologies
2. To Learn knowledge representation for Semantic Web
3. To understand the importance of Social Network Analysis
4. To understand and use semantic web technologies for social network analysis

Course Outcomes: At the end of the course, the students will be able to :

- Understand the Semantic Web and Social Networks
- Understand Electronic sources for network analysis and different ontology languages.
- Model and aggregate social network data.
- Design and Analyze social network using semantic web technologies.

Pre-requisites: Web Technologies; Data Structures, Databases, Logic-First order logic, knowledge representation, Data Mining ,Distributed Systems.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction Semantic Web and Social Networks: .	The Semantic Web- Limitations of the current Web, The semantic Web Technologies ,A Layered Approach, The emergence of the social web. Social Network Analysis- What is network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis	**04**
2	Semantics and Knowledge Representation on the Semantic Web	Electronic sources for network analysis- Electronic discussion networks, Blogs and online communities Structured Web Documents-XML, Describing web Resources-RDF, RDFSchema, Querying Knowledge Representation on the Semantic Web-SPARQL	**10**

3	Modeling and aggregating social network data:	Ontologies and their role in the Semantic Web, Ontology languages for the Semantic Web-RDFS, OWL. State-of-the-art in network data representation, Ontology Engineering, Semantic Web Knowledge Management Architecture ,Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data.	**10**
4	Developing social-semantic applications:	Building Semantic Web applications with social network features, Flink: the social networks of the Semantic Web community, open academia: distributed, semantic-based publication management	**08**
5	Extracting and Mining Communities in social network and social network analysis-	Extracting evolution of Web Community from series of web archive – Detecting communities in social networks- Definition of community – Evaluating communities – methods for community detection and mining – Semantic based social network analysis.	**08**
6	Applications of community mining algorithms , Visualization-	Applications of community mining algorithms-Influence and Homophily, Recommendation, Behavior Analytics, Visualization- Graph theory – Centrality – Clustering- Node Edge Diagrams –Matrix Representation –,Benefits of semantic social networks for communities	**08**

Text Books:

1. Grigoris Antoniou and Frank van Harmelen "Semantic Web Primer"second edition
2. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
3. Reza Zafarani,Mohammad Ali Abbasi,Huan Liu "Social Media Mining: Introduction",Cambridge University press.

Reference Books:

1. Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking Techniques and applications", First Edition Springer, 2011.
2. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Retrieval and Access: Techniques for Improved user Modelling",IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009.
5. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011.

6. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
7. Toby Segaran,colin Evans and Jamie Taylor "Programming Semantic Web", O'Reilly.
8. Berners Lee, Godel and Turing "Thinking on the Web ",Wiley inter science, 2008.
9. Vladimir Geroimenko, Chaomei Chen "Visualizing the Semantic Web", Springer 2006.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSDLO2025	Information and Communication Technologies (ICT) for Social Cause	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination						
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg		Term Work	Pract	Oral
		20	20	20	80	--	--	--

Course Objectives:

1. To understand use of ICT techniques in various applications.
2. To Recognize, Represent and Design the ICT systems for social cause.

Outcome: Learner will able

- To understand technologies used in ICT.
- To design and implement ICT application for societal benefits
- To demonstrate use of emerging technology for social applications.

Sr. No.	Module	Detailed content	Hours
1	Basics of ICT	▪ Introduction to ICT ▪ Challenges and opportunities in using technology for a social cause. ▪ Understanding the social and cultural influences that affect users. ▪ Creating an ICT – handling text, data and media	4
2	Communication Techniques in ICT	▪ Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth ▪ Satellite Techniques – architecture AND working principles GPS/GPRS ▪ Cloud computing – Introduction, cloud services, Cloud service providers, ▪ GIS– Working principle and architecture for ICT	12
3	Data acquisition in ICT	• Recognition systems RFID,OMR • Data acquisition process for MEMS devices • Sensors – Programming, communication with cloud. • Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc	8
4	Data Management in ICT	▪ Data management ▪ Data storage structures	8

5	knowledge management in ICT	▪ Knowledge elicitation ▪ Knowledge Engineering Methodology ▪ Knowledge representation and visualization techniquesAutomatic discovery programs ▪ Data visualization ▪ Auditing knowledge management ▪ Linking knowledge management to business performance	8
6	ICT applications and Social Audit	• Study of ICT applications in various domains such as Agriculture, Healthcare, Education, SCM, Finance, Law. • Social Audit: The Social Audit Tool (SAT), Social Auditing, Characteristics of the SAT, Uses of the SAT , Benefits of the SAT, The SAT Methodology , Purposes, Method, and Approach of the SAT, Implementing the SAT, The Social Auditor	10

References Books:

1. ICT Futures :Delivering Pervasive Realtime And Secure Services Edited By Paul Warren, Jhon Davies, David Brown , Wiley Publication
2. Jochen Schiller, "Mobile communications", Addison wisely, Pearson Education.
3. GIS Fundamentals, Applications and Implementation, Dr.K.Elangovan, New India Publications.
4. Cloud Computing : A practical Approach: By Anthony T. Velte : Tata McGraw-Hill
5. An Introduction to Microelectromechanical systems Engineering, NadimMaluf , Artech House.
6. Knowledge management business intelligence , and content management : The IT practitioner's Guide by Jessica Keyes
7. ICTs for transfer of technology tools and techniques , S.R. Verma , New India
8. USAID, Social Audit Tool Handbook, Using the Social Audit to Assess the Social Performance of Microfinance Institutions,2008.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credits
ILO 2021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.	8

	Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO 2022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs;	10

	Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	Enterpreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7

03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis	**08**

	i. Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 2028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition	04

	(Process of Digital Transformation)	
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO2029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSL201	Computational Laboratory II	--	--	--	---	02	--	01
		Examination Scheme						
		Theory Examination				Term Work	Pract / Oral	
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	

Module	Detailed Content	Lab Session
High Performance Computing	Implement any two parallel algorithms(e.g. sorting, matrix- matrix multiplication) using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.	04
Data Science	Exploratory data analysis using Map Reduce , NoSQL, R, python and Hadoop Ecosystem Predictive data Analytics using open source tools like Rstudio, RWeka, RHadoop	04
Ethical Hacking and Digital Forensics	Operating System Forensics, Email Forensics and Mobile Forensics using open source forensics tools (e.g., Helix3pro, WinHex)	04

Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">CSL202</td><td rowspan="6">DEC Laboratory-II</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td colspan="2" rowspan="3">Pract / Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>---</td><td>---</td><td>---</td><td>---</td><td>25</td><td colspan="2">25</td></tr>
</table>

Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS301	Special Topic Seminar	----	06	--	---	03	--	03
ME-CS302	Dissertation-I	---	24	--	---	12	--	12
Total		----	30	--	---	15	--	15

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ME-CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
ME-CS302	Dissertation-I	---	---	---	----	---	100	---	100
Total		---	---	---	----	---	150	50	200

Guidelines Special Topic Seminar:

- Seminar should be based on thrust areas in Computer Engineering/ Information Technology.
- Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
- Students should use multiple literatures (at least 10 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Implementation of one paper from refereed journal as a case study.
- Compile the report in standard format and present infront of Panel of Examiners. (Pair of Internal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputed International / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS401	Dissertation-II	--	30	--	---	15	--	15
Total		--	30	--	---	15	--	13

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
ME-CS401	Dissertation-II	--	---	---	---	---	100	100	200
Total		--	---	---	---	---	100	100	200

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.

UNIVERSITY OF MUMBAI
No. UG/213of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the Ph. D. Course Work **vide** this office Circular No.UG/121 of 2015-16, dated 24th November, 2015 and the Directors/Heads of the University Departments, Dean/Principals of the affiliated Colleges in Faculty of Technology and Engineering, Pharmacy, Architecture and MCA. are hereby informed that proposal received from Co-ordinator Faculty of Technology, approved by the Academic Council at its meeting held on 30th September, 2016 **vide** item No. 4.17 and in accordance therewith, the revised syllabus as per the Choice Based Credit System of Ph. D. Course Work for Engineering Faculty, which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2017–2018.

MUMBAI – 400 032
4th January, 2017

(Dr.M.A.Khan)
REGISTRAR

To,
The Directors/Heads of the University Departments, Dean/Principals of the affiliated colleges in Faculty of Technology and Engineering, Pharmacy, Architecture and MCA.

A.C/4.17/30.09.2016

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No. UG/213-A of 2016-17 MUMBAI-400 032 4th January, 2017

Copy forwarded with Compliments for information to:-

1) The Co-ordinator, faculties of Technology and Engineering,
2) The Chairman & Chairperson of the board of Studies & Ad-Hoc Board of Studies of various subject at faculty of Technology and Engineering, Pharmacy, Architecture and MCA,
3) The Director, Board of College and University Development,
4) The Co-Ordinator, University Computerization Centre,
5) The Controller of Examinations.

(Dr.M.A.Khan)
REGISTRAR

PTO..

AC – 30/09/2016

Item No. 4.17

UNIVERSITY OF MUMBAI

Revised Syllabus for PhdCourse Work

(As per Credit Based Semester and Grading System with effect from the academic year 2017–2018)

Course Work Structure for Phd Program in Faculty of Technology
Mumbai University

(With effect from Academic Year 2017-18)

CODE	NAME OF COURSE	CONTACT HOURS	CREDITS	EXAMINATION SCHEME				
				MID TERM TEST	END SEMESTER EXAM	TERM WORK	SEMINAR PRESENTATION	TOTAL
Phd101	Research Methodology	6	6	20	80	--	--	100
Phd102	Course suggested by Guide*	6	6	20	80	--	--	100
Phd103	Seminar	-	4	-	-	50	50	100
Total		12	16	40	160	50	50	300

Grading of Research Candidates Performance

Awarding of gradesto research candidates based on their performance shall be done as per the applicable ordinances and regulations for undergraduate and Post graduate programs of Engineering under the Faculty of Technology. Semester Grade Point Index (SGPI) shall be also calculated based on the ordinances and regulations applicable for engineering programs under Faculty of Technology. Approved and recognized Research Centers shall prepare Phd course work grade card after successful completion of course work and issue to candidates and one copy to University concerned section for record.

Course Code	Course Name	Credits
PhdC101	**Research Methodology**	**06**

Module	Detailed content	Hrs.
1	**Definition and Characteristics of Research:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	8
2	**Types of Research:** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size.	10
3	**Outcome of Research:** Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis, Preparation of the Report on conclusions reached, Testing validity of research outcomes, Suggestions and recommendations, identifying future scope.	10
4	**Probability Distribution and Hypothesis Testing:** Theoretical: binomial, poisson, normal, exponential, hyper geometric, uniform distributions. Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, Z test and χ^2 test for goodness of fit, ANOVA (one way classification), Non parametric tests: sign test, U test.	14
5	**Correlation and Regression Analysis**: Karl Pearson's and Rank Correlation coefficient, simple linear regression: least squares method, Linear Programming:Graphical solution, simplex method, dual, sensitivity analysis, transportation and assignment problems.	10
6	**Management Decision Making & Computer Applications:** System approach, decision making under uncertainty and risk: decision tables and decision tree. Statistical data analysis: generating charts/ graph and other features. Introduction to tools: Tools used may be Microsoft Excel, Open office, Microsoft Power Point or similar tools.	8

References:

1. Dawson, Catherine, 2002, *Practical Research Methods,* New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques,* New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nd.ed), Singapore, Pearson Education.
4. *Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley*
5. Goode W J &Hatt P K, Methods in social research, McGraw Hill
6. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)

Course Code	Course Name	Credits
PhdC102	**Course suggested by Guide***	**06**

This courseis to be suggested by guide/supervisor in specific domain area of research undertaken by the research candidate.

Research candidates can undertake this course in consultation with guide/supervisor as per guidelines given below;

1. Relevant course shall be successfully completed in IITBombay which has 6 credits.

OR

1. Relevant PG course in the research domain area of research candidate at any PG center affiliated to University of Mumbai.
   In this case, PG course as per University of Mumbai syllabus is of 4 credits. Thus additional work needs to be done for remaining 2 credits. (Any relevant PG course suggested by guide 4 credits + additional work suggested by guide for 2 credits).

   Additional work may be in line with any of the following guidelines:
   i. Minimum four assignment problemsfrom same domain area

   OR

   ii. Any relevant PG Laboratory course, as per University of Mumbai PG syllabus, suggested by guide

   OR

   iii. One course project from same domain area

   OR

   iv. One simulation based project in the domain area using relevant software tool.

Course Code	Course Name	Credits
PhdS103	**Seminar**	**04**

Following guidelines for credit seminar shall be followed:

1. Seminar should be based on thrust areas in specific research domain.
2. Research scholar should do literature survey, identify the topic for seminar and finalize the same in consultation with Guide/Supervisor.
3. Research scholar is expected to use multiple literatures and understand the topic.
4. Report should be compiled in the standard format as per University Guidelines for report writing and present in front of pair of Examiners appointed by the Head of the Department/Institute of respective Program.

Seminar should be assessed jointly by the pair of Internal and External Examiners

Following points must be assessed during the presentation of Credit Seminar

i. Quality of Literature survey and Novelty in the topic
ii. Relevance to the specialization
iii. Understanding of the topic
iv. Quality of Written and Oral Presentation

AC- 23/07/2020
Item No. : 122

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering
in
Electronics Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC-23/07/2020
Item No. 122

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B E in Electronics Engineering**
2	Eligibility for Admission	**First Year Engineering passed in line with the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/**UG**/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester**/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	**New**/~~Revised~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date:23rd July 2020 Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.
There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and implementation of online contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of ‘C ‘scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD’s/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics Engineering program to be implemented from academic year 2020-21. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

SEMESTER III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical And Oral	Tutorial	Total
ELC301	**Engineering Mathematics - III**	3	--	1	3	--	1	**4**
ELC302	**Electronics Devices and Circuits - I**	3	--	--	3	--	--	**3**
ELC303	**Digital Logic Circuits**	3	--	--	3	--	--	**3**
ELC304	**Electrical Networks Analysis and Synthesis**	3	--	1	3	--	1	**4**
ELC305	**Electronic Instruments and Measurements**	3	--	--	3	--	--	**3**
ELL301	**Electronics Devices and Circuits - I Lab**	--	2	--	--	1	--	**1**
ELL302	**Digital Logic Circuits Lab**	--	2	--	--	1	--	**1**
ELL303	**Electronic Instruments and Measurements Lab**	--	2	--	--	1	--	**1**
ELL304	**Skill base Lab OOPM:** ***(C++ and Java)***	--	4	--	--	2	--	**2**
ELM301	**Mini Project – 1A**	--	4$	--	--	2	--	**2**
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

$ indicates work-load of Learner (Not of Faculty), for Mini Project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical & Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ELC301	Engineering Mathematics - III	20	20	20	80	3	25	--	125
ELC302	Electronics Devices and Circuits - I	20	20	20	80	3	--	--	100
ELC303	Digital Logic Circuits	20	20	20	80	3	--	--	100
ELC304	Electrical Networks Analysis and Synthesis	20	20	20	80	3	25	--	125
ELC305	Electronic Instruments and Measurements	20	20	20	80	3	--	--	100
ELL301	Electronics Devices and Circuits - I Lab	--	--	--	--	--	25	25	50
ELL302	Digital Logic Circuits Lab	--	--	--	--	--	25	25	50
ELL303	Electronic Instruments and Measurements Lab	--	--	--	--	--	25	25	50
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	--	--	--	--	50	--	50
ELM301	Mini Project - 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**200**	**100**	**800**

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: 1 hour per week per four groups

   Major Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII– ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	TW/Pract.	Tutorial	Total
ELC301	Engineering Mathematics - III	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Avg of Test 1 & 2					
ELC301	Engineering Mathematics - III	20	20	20	80	25	--	--	125

Pre-requisite:

Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors,

Course Objectives: The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills
3. To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra and its applications
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: On successful completion of course learner will be able to;

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables.
5. Illustrate the use of matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module No	Contents	Hrs.
01	**Laplace Transform** 1.1 Definition of Laplace transform Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t,* Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	**7**
02	**Inverse Laplace Transform** 2.1. Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Fourier Series** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Complex Variables** 4.1 Function *f*(z)of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7

05	**Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley-Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Vector Differentiation and Integral** 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	6
	Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Advanced Engineering Mathematics,H.K. Das, S. Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics,Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw HillPublication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	TW/Practical and Oral	Tutorial	Total
ELC302	Electronic Devices & Circuits - I	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours	-	-	-
		Test 1	Test 2	Avg of Test 1 and Test 2		-	-	-	-
ELC 302	Electronic Devices & Circuits - I	20	20	20	80	03	--	--	100

Course Objectives:

1. To deliver the knowledge about physics of basic semiconductor devices and circuits.
2. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To analyze and design electronic circuits using semiconductor devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Explain working of semiconductor devices.
2. Analyze characteristics of semiconductor devices.
3. Perform DC and AC analysis of Electronics circuits.
4. Compare various biasing circuits as well as various configurations of BJT and MOSFETs.
5. Select best circuit for the given specifications/application.
6. Design electronics circuits for given specifications.

Module No.	Unit No.	Contents	Hrs.
1		**PN Junction Diode**	06
	1.1	Fermi level concepts, Basic Diode Structure, Energy Band Diagrams, Zero Applied Bias, Forward bias, Reverse bias, PN junction current, drift and diffusion current, junction capacitance.	
	1.2	DC load line, small signal model, Applied Bias, Reverse Applied Bias, temperature effects.	
2		**Diode applications and Special semiconductor devices**	04
	2.1	Clippers and Clampers, Zener as voltage regulator.	
	2.2	Construction, Working and Characteristics of :Schottky diode, Solar Cells, Photodiodes, LEDs.	
3		**Bipolar Junction Transistor**	10
	3.1	BJT operations, voltages and currents, BJT characteristics (CE, CB, CC configurations), early effect.	
	3.2	DC Circuit Analysis: DC load line and region of Operation, Common Bipolar Transistor Configurations, biasing circuits, bias stability and compensation, analysis and design of biasing circuits.	
	3.3	AC Analysis of BJT Amplifiers: AC load line, small signal models: h-parameter model, re model, Hybrid-pi model. Ac equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE, CB and CC amplifiers using Hybrid-pi model only.	
4		**Field Effect Devices**	10
	4.1	JFET: Construction, operation and characteristics. MOSFET: Construction, operation and characteristics of D-MOSFET and EMOSFET.	
	4.2	DC Circuit Analysis: DC load line and region of operation, Common-MOSFETs configurations, Analysis and Design of Biasing Circuits	
	4.3	AC Analysis: AC load line, Small-Signal model of MOSFET and its equivalent Circuit, Small-Signal Analysis MOSFET Amplifiers (Common-Source, Source Follower, Common Gate)	
5		**Rectifiers and Filters**	04
	5.1	Rectifiers: Working and analysis of Full wave and Bridge	
	5.2	Filters: C, L, LC, pi.	
6		**Design of Electronic Circuits**	05
	6.1	Design of single stage CE amplifier	
	6.2	Design of single stage CS MOSFET amplifier	
	6.3	Design of full wave rectifier with LC and pi filter.	
		Total	**39**

Text Books:

1. Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, "Microelectronic Circuits Theory and Applications", International Version, OXFORD International Students Edition, Fifth Edition.

Reference Books:

1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill
5. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ELC303	Digital Logic Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours		--	--
		Test 1	Test 2	Avg of Test 1 and Test 2	--	--	--	--	--
ELC303	Digital Logic Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

Basic Electrical & Electronics Engineering

Course Objectives:

1. To understand various number system & amp; codes and to introduce the students to various logic gates, SOP, POS form and their minimization techniques.
2. To teach the working of combinational circuits, their applications and implementation of combinational logic circuits using MSI chips.
3. To teach the elements of sequential logic design, analysis and design of sequential circuits.
4. To understand various counters and shift registers and its design using MSI chips.
5. To explain and describe various logic families and Programmable Logic Devices.
6. To train students in writing program with Verilog hardware description languages.

Course Outcome:

After successful completion of the course students will be able to;

1. Perform code conversion and able to apply Boolean algebra for the implementation and minimization of logic functions.
2. Analyse, design and implement Combinational logic circuits.
3. Analyse, design and implement Sequential logic circuits.
4. Design and implement various counter using flip flops and MSI chips.
5. Understand TTL & amp; CMOS logic families, PLDs , CPLD and FPGA.
6. Understand basics of Verilog Hardware Description Language and its programming with combinational and sequential logic circuits.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Digital Design**	7
	1.1	**Number Systems and Codes:** Review of Number System, Binary Code, Binary Coded Decimal, Octal Code,Hexadecimal Code and their conversions, Binary Arithmetic: One's and two's complements,	
	1.2	**Codes :**Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
	1.3	**Logic Gates and Boolean Algebra:** Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables	
2		**Combinational Circuits using basic gates as well as MSI devices**	6
	2.1	**Arithmetic Circuits:** Half adder, Full adder, Ripple carry adder, Carry Look ahead adder, Half Subtractor, Full Subtractor, multiplexer, cascading of Multiplexer , demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1).	
	2.2	**MSI devices :** IC7483, IC74151, IC74138, IC7485.	
3		**Elements of Sequential Logic Design**	6
	3.1	**Sequential Logic:** Latches and Flip-Flops. RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops,	
	3.2	**Counters:** Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counter,Twisted ring counter, Shift Registers, Universal Shift Register.	
4		**Sequential Logic Design**	7
	4.1	**Sequential Logic Design:**Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques (inspection, partition and implication chart method) and state assignment,sequence detector, Clocked synchronous state machine design.	
	4.2	**Sequential logic design practices :**MSI counters (7490, 7492, ,7493,74163, 74169) and applications, MSI Shift registers (74194) and their applications.	
5		**Logic Families and Programmable Logic Devices**	6
	5.1	**Logic Families:** Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND,(Operation of TTL NAND gate), CMOS Logic :- CMOS inverter,CMOS NAND and CMOS NOR, Interfacing CMOS to TTL and TTL to CMOS.	
	5.2	**Programmable Logic Devices**: Concepts of PAL and PLA. Simple logic implementation using PAL and PLA. Introduction to CPLD and FPGA architectures, Numerical based on PLA and PAL.	
6		**Introduction to Verilog HDL**	7
	6.1	**Basics**: Introduction to Hardware Description Language and its core features, synthesis in digital design, logic value system, data types, constants, parameters, wires and registers. **Verilog Constructs:** Continuous & procedural assignment statements, logical, arithmetic, relational, shift operator, always, if, case, loop statements, Gate level modelling, Module instantiation statements.	
	6.2	**Modelling Examples:** Combinational logic eg. Arithmetic circuits, Multiplexer, Demultiplexer, decoder, Sequential logic eg. flip flop, counters.	
		Total	**39**

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. Morris Mano, Digital Design, Pearson Education, Asia 2002.
3. J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing, 2018.

Reference Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.
3. Stephen Brown and ZvonkoVranesic, Fundamentals of digital logic design with Verilog design, McGraw Hill, 3rd Edition.
4. Digital Circuits and Logic Design – Samuel C. Lee , PHI
5. William I.Flectcher, "An Engineering Approach to Digital Design", PrenticeHall of India.
6. Parag K Lala, "Digital System design using PLD", BS Publications, 2003.
7. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.

Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ELC304	Electrical Network Analysis & Synthesis	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC304	Electrical Network Analysis & Synthesis	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. Basic Electrical Engineering
2. Engineering Mathematics I and II

Course Objectives:

1. To learn electrical networks and its analysis in time and frequency domain.
2. To understand synthesis of electrical networks.
3. To understand various types of filters.

Course Outcomes:

After successful completion of the course students will be able to;

1. Explain basic electrical circuits with nodal and mesh analysis and apply network theorems.
2. Apply Laplace Transform for steady state and transient analysis.
3. Determine different network functions and solve complex circuits using network parameters.
4. Realize electrical networks for given network functions using synthesis concepts.
5. Design various types of filters.

Module No.	Unit No.	Contents	Hrs.
1		**Analysis of Circuits**	10
	1.1	**Analysis of DC circuits with dependent sourcesusing**: generalized loop, node matrix analysis, Superposition, Thevenin, Norton's and Maximum Power Transfer theorems.	
	1.2	**Analysis of Coupled Circuits:** Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis.	
2		**Time and Frequency Domain Analysis of Electrical Networks**	8
	2.1	**Time Domain Analysis of Electrical Networks:** Forced and natural response,Initial and final conditions in network elements, Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, Transient and steady state response.	
	2.2	**Frequency Domain Analysis of Electrical Networks:** S-domain representation, Concept of complex frequency, Applications of Laplace Transform in solving electrical networks.	
3		**Two Port Networks**	9
	3.1	**Network Functions:**Driving point and Transfer Function, Poles and Zeros, Analysis of ladder networks.	
	3.2	**Two Port Parameters:** Open circuit, Short circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity and symmetry conditions.	
	3.3	**Series/parallel connection:** T and Pi representations, interconnection of Two-Port networks.	
4		**Synthesis of Electrical Networks**	7
	4.1	**Realizability Concept:** Hurwitz polynomial, Concept of positive real function, testing for necessary and sufficient conditions for positive real functions.	
	4.2	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point functions, Foster and Cauer forms.	
5		**Introduction to filters**	5
	5.1	**Basic filter circuits:** Low pass, high pass, band pass and band stop filters, cut-off frequency, bandwidth, quality factor, attenuation constant, phase shift, characteristic impedance.	
	5.2	**Design and analysis of filters:** Constant K filters	
		Total	**39**

Text Books:

1. Network Analysis, M. E. Van Valkenburg/T.S. Rathore, Pearson Education, 3rd Edition (2019).
2. Engineering Circuit Analysis, William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven Durbin McGraw Hill, 9th Edition (2018).
3. Networks and Systems, Ashfaq Husain, Khanna Book Publishing Co. (P) Ltd.; 2nd Edition (2019).
4. Circuits and Networks: Analysis and Synthesis, A. Sudhakar and S.P. Shyammohan McGraw Hill Education (India) Private Limited; 5th edition (2015).

Reference Books:

1. Circuit Theory Analysis and Synthesis, A. Chakrabarti, DhanpatRai& Co., Seventh - Revised edition (2018)
2. MahmoodNahvi and Joseph A. Edminister, "Schaum's Outline of Electrical Circuits",McGraw-Hill Education, 7th Edition (2017).
3. Problems and Solutions of Electrical Circuit Analysis, R.K. Mehta & A.K. Mal, CBS Publishers and Distributors Pvt Ltd (2015).
4. Networks and systems, D. Roy Choudhary, New Age International Publishers, 2nd Edition (2013).

Term Work:

This shall consist of at least 10 tutorials based on the entire syllabus.Each tutorial shall have a minimum of four numerical problems solved and duly graded.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub- questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC305	Electronic Instruments and Measurements	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC305	Electronic Instruments and Measurements	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. FEC101-Engineering Mathematics-I
3. FEC201-Engineering Mathematics-II

Course Objectives:

1. To develop understanding of fundamental principles of electronic measurements.
2. To disseminate basic methods for measurements of electrical quantities.
3. Toimpart knowledge of analog and digital instrumentation.

Course Outcomes:
After successful completion of the course students will be able to:

1. Recall and define instrument characteristics as well as interpret errors in measurements.
2. Understand and Measure various variables or value of unknown element.
3. Illustrate digital instruments like digital voltmeter, signal generator, wave analyzer.
4. Explain various components of oscilloscopes.
5. Choose appropriate transducer for measurement of distance, temperature and pressure.
6. Develop a calibration scheme for given instrument.

Module No.	Unit No.	Contents	Hrs.
1	**Fundamental Principles of Measurement**		04
	1.1	Measurement units (SI units of current, charge, EMF, potential difference, voltage, resistance, conductance, magnetic flux & flux density, inductance & capacitance). Components of a general measurement system (instrument).	
	1.2	Instrument characteristics: Static (accuracy, precision, linearity, drift, sensitivity, resolution, hysteresis, dead band). Dynamic (Speed of response, fidelity, lag and dynamic error)	
	1.3	Errors in Measurement: Classification of Errors, methods to eliminate or minimize the errors. Statistical analysis of Errors.	
2	**Measurement of Resistance, Inductance and Capacitance**		08
	2.1	The concept of measurement with bridge, measurement of low, medium and high resistances using Wheatstone bridge, Kelvin double bridge and mega-ohm bridge (Megger). Numerical problems (computation of sensitivity, resolution, range, errors)	
	2.2	Measurement of Inductance, Capacitance and Frequency: Maxwell bridge, Anderson bridge, Hay's bridge, Schering bridge, Wien's bridge. LCR-Q meter. Numerical problems (computation of sensitivity, resolution, range, errors)	
3	**Electronic Instruments**		08
	3.1	Digital DC Voltmeters (DVM): Ramp, dual slope, integrating, successive approximation. AC Voltmeters: Rectifier, average responding, peak responding, true RMS meter. Digital multimeter (DMM), Digital phase meter.	
	3.2	Signal Generators: Low frequency signal generator, function generator, pulse generator, sweep frequency generator.	
	3.3	Wave analyzer: Basic wave analyzer, frequency selective and heterodyne. Harmonic distortion analyzer, spectrum analyzer.	
4	**Oscilloscopes**		08
	4.1	Cathode Ray Oscilloscope: Block diagram of CRO, deflection generator, horizontal sweep generator, delay line, single and dual beam, dual trace CRO, chop and alternate modes	
	4.2	Measurements using Oscilloscope: Measurement of voltage, frequency and phase. Lissagous figures and their use in phase and frequency measurement.	
	4.3	Digital Storage Oscilloscope: Basic DSO operation, sampling rate, auto-set.	
5	**Sensor and Transducers**		08
	5.1	Basics of Sensors and Transducers: Definitions, difference, characteristics, classification and criteria for selection.	
	5.2	Transducers for measurement of- temperature: RTD, thermister, thermocouple, comparison of all three; displacement: Potentiometer, capacitive transducers, LVDT, strain gauge; pressure: load cell, dead weight tester; level: ultrasonic and optical.	
6	**Instrument Calibration**		03
	6.1	Principles and characteristics of calibration. Need of calibration.	
	6.2	Calibration of potentiometer. Use of potentiometer for calibration of voltmeter. DMM as standard instrument for calibration.	
	Total		**39**

Text Books:

1. David Bell, "Electronic Instrumentation and Measurements", Oxford Publishing, 2nd edition, 2003.
2. A. D. Helfrick, W. D. Cooper, "Modern Electronics Instrumentation and Measurement Techniques", NJ. Prentice Hall, 2002.
3. H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill, 2nd edition, 2004.

Reference Books:

1. C. S. Rangan, G. R. Sarma, V. S. V. Mani, "Instrumentation: Devices and Systems", Tata McGraw Hill, 2nd edition, 2004.
2. A. K. Sawhney, "Electrical and Electronic Instruments and Measurements", DhanpatRai& Sons, Delhi, 2015.
3. D. Prensky, "Electronic Instrumentation", Prentice Hall Publication.
4. S. K. Singh, "Industrial Instrumentation and Control", Tata McGraw Hill, 3rd Edition, 2017.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL301	Electronic Devices & Circuits - I Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL301	Electronic Devices & Circuits - I Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of ELC302 (Electronic Devices and Circuits I) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Title
1	To study passive(R,L,C) and active (BJT,MOSFTET) components.
2	To study equipment (CRO, Function Generator, Power supply).
3	To perform characteristics of PN junction diode.
4	To perform Clippers and Clampers.
5	To perform analysis and design Fixed bias, voltage divider bias for CE amplifier.
6	To perform CE amplifier as voltage amplifier (Calculate Av, Ai, Ri, Ro).

7	To perform CS MOSFET amplifier as voltage amplifier and measurement of its performance parameters.
8	To perform Full wave/Bridge rectifier with LC/pi filter.
9	To perform Zener as a shunt voltage regulator.
10	To design Full wave/Bridge rectifier with LC/pi filter.
11	To design single stage CE Amplifier.
12	To design single stage CS Amplifier.

Suggested Simulation Experiments:

Sr. No.	Experiment Title
1	SPICE/NGSPICE simulation of and implementation for junction analysis
2	SPICE/NGSPICE simulation of and implementation for BJT characteristics
3	SPICE/NGSPICE simulation of and implementation for JFET characteristics
4	SPICE/NGSPICE simulation of for MOSFET characteristics
5	SPICE/NGSPICE simulation of Full wave/Bridge rectifier with LC/pi filters.
6	SPICE/NGSPICE simulation of CE amplifier
7	SPICE/NGSPICE simulation of CS MOSFET amplifier.

(Expected percentage of H/w and software experiments should be 60% & 40% respoectively)

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL302	Digital Logic Circuits Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical &Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL302	Digital Logic Circuits Lab	--	--	--	--	--	25	25	50

Term Work:
At least 10 experiments covering entire syllabus of ELC 303 (Digital Logic Circuits) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Course Objective:-

1. To learn the functionality of basic logic gates.
2. To Construct combinational circuits and verify their functionalities.
3. To learn the functionality of flip flops and their conversion.
4. To Design and implement synchronous and asynchronous counters, Shift registers using MSI.
5. To simulate various combinational and sequential circuits and analyze the results using Verilog HDL.

Suggested List of Experiments:

Sr. No.	Hardware Experiment Title
1	To verify different logic gates and implement basic gates using universal gates
2	To implement Boolean function in SOP and POS form
3	To implement half adder, full adder, half Subtractor, full Subtractor
4	To implement BCD adder using binary adder IC 7483

5	To implement logic equations using Multiplexer IC 74151
6	To verify truth table of SR,JK,T and D flip flops
7	To perform Flip flop conversion JK to D, JK to T and D to T flip flop
8	To implement MOD N counter using IC 7490/7492/7493
9	To implement Synchronous counter using IC 74163/74169 **OR** To implement universal shift register using IC 74194

Simulation/Software Experiments

Sr. No.	Software Experiment Title
1	To design and simulate Full adder/full subtractor using Verilog HDL
2	To design and simulate Multiplexer/Demultiplexer using Verilog HDL
3	To design and simulate decoder 74138 using Verilog HDL
4	To simulate basic flip flops using Verilog HDL
5	To design and simulate 4 bit counter / up-down counter using Verilog HDL
6	To design and simulate Shift register using Verilog HDL

(Additional suggested experiments (optional) *Implementation of any of above using* ***FPGA/CPLD)***

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL303	Electronic Instruments and Measurements Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL303	Electronic Instruments and Measurements Lab	--	--	--	--	--	25	25	50

Course Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate the instrument characteristics as well as interpret errors in measurements.
2. Measure various variables or value (R, L and C) of unknown element.
3. Illustrate digital instruments like digital voltmeter, signal generator, wave analyzer.
4. Explain various functions of oscilloscopes.
5. Choose appropriate transducer for measurement of distance, temperature and pressure.
6. Develop a calibration scheme for given instrument.

Term Work:

At least 10 experiments covering entire syllabus of ELC303 (**Electronic Instruments and Measurements**) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

Sr. No.	Hardware Experiment Title
1	Study of DSO for measurements of voltage, frequency and phase.
2	Measurement of resistance using wheat-stone /kelvin bridge.
3	Measurement of inductance and Q-factor using Hay's bridge.
4	Measurement of capacitance using Schering bridge.
5	Measurement of frequency using Wien bridge.
6	Study characteristics and use of LVDT.
7	Measurement of temperature using RTD/Thermister.
8	Measurement of displacement using strain gauge.
9	Calibration of potentiometer.
10	Calibration of voltmeter using potentiometer/DMM.

Simulation/Software Experiments

Sr. No.	Software Experiment Title
1	Simulation of the zeroth, first order and second order Instrument to understand its dynamic characteristics.
2	Simulation of measurement of rms , average with error indication
3	Simulation of the Working of multichannel oscilloscope and demonstrate the different modes
4	Simulation of measurement of various physical parameters such as Temperature, distance or pressure.
5	Simulation of DAS
6	Simulation of the calibration method and its performance evaluation

Preferably open source software should be used for implementation.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently..

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	02* + 02	--	--	02	--	02
* *Theory class to be conducted for full class*								

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ELL304	Skill base Lab - OOPM: *(C++ and Java)*	--	--	--	--	--	50	--	50

Course Pre-requisites:

- Fundamentals of C-Programming

Course Objectives:

1. To understand Object Oriented Programming basics and its features.
2. To understand and apply Object Oriented Programming (OOP) principles using C++
3. Able to implement Methods, Constructors, Arrays, Multithreading and Applet in java
4. Able to use a programming language to resolve problems.

Course Outcomes:

After successful completion of the course student will be able to;

1. Use C++ in programming.
2. Use different control structures.
3. Understand fundamental features of an object oriented language: object classes and interfaces, exceptions and libraries of object collections.
4. Understand Java Programming.
5. To develop a program that efficiently implements the features and packaging concept of java in laboratory.
6. To implement Exception Handling and Applets using Java.

Module No.	Unit No.	Topics	Hrs.
1		**C++ Overview**	08
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object orientedprogramminglanguage.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2		**C++ Control Structures**	06
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One dimensional and Multidimensional array.	
3		**Object-Oriented Programming using C++**	10
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4		**Introduction to Java**	06
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based.Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5		**Inheritance, Polymorphism, Encapsulation using Java**	10
	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	

	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6		**Exception Handling and Applets in Java**	08
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception subclasses). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
	Total		**48**

Textbooks:

1. BjarneStroustrup, “The C++ Programming language”, Third edition, Pearson Education, 2000.
2. Deitel, “C++ How to Program”, 4th Edition, Pearson Education, 2005.
3. D. T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition, 2015.
4. YashwantKanitkar, “Let Us Java”, BPB Publications, 4nd Edition, 2019.

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, 10th Edition, 2017.
2. Harvey M. Deitel, Paul J. Deitel, Java: How to Program, 8th Edition, PHI , 2009.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education.
4. SachinMalhotra, SaurabhChaudhary “Programming in Java”, Oxford University Press, 2010

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Suggested list of Experiments:

Sr. No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least **16** experiments (**08 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiments and are graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course code	Course Name	Credits
ELM 301	Mini Project - 1A	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELM 301	Mini Project - 1A	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book: 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on the following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Second Year Electronics Engineering

UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

SEMESTER IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC401	**Engineering Mathematics - IV**	3	--	1	3	--	1	**4**
ELC402	**Electronics Devices and Circuits - II**	3	--	--	3	--	--	**3**
ELC403	**Microcontroller Applications**	3	--	--	3	--	--	**3**
ELC404	**Principles of Communication Engg**	3	--	1	3	--	1	**4**
ELC405	**Signals and Systems**	3	--	--	3	--	--	**3**
ELL401	**Electronics Devices and Circuits - II Lab**	--	2	--	--	1	--	**1**
ELL402	**Microcontroller Applications Lab**	--	2	--	--	1	--	**1**
ELL403	**Analog Communication Lab**	--	2	--	--	1	--	**1**
ELL404	**Skill Base Lab : *Python Programming***	--	4	--	--	2	--	**2**
ELM401	**Mini Project - 1B**	--	4$	--	--	2	--	**2**
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

$ indicates workload of Learner (Not for Faculty), for Mini Project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical and oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (inHrs)			
		Test 1	Test 2	Avg.					
ELC401	**Engineering Mathematics - IV**	20	20	20	80	3	25	--	**125**
ELC402	**Electronics Devices and Circuits -II**	20	20	20	80	3	--	--	**100**
ELC403	**Microcontroller Applications**	20	20	20	80	3	--	--	**100**
ELC404	**Principles of Communication Engg**	20	20	20	80	3	--	--	**100**
ELC405	**Signals and Systems**	20	20	20	80	3	25	--	**125**
ELL401	**Electronics Devices and Circuits - II Lab**	--	--	--	--	--	25	25	**50**
ELL402	**Microcontroller Applications Lab**	--	--	--	--	--	25	25	**50**
ELL403	**Analog Communication Lab**	--	--	--	--	--	25	25	**50**
ELL404	**Skill Base Lab : *Python Programming***	--	--	--	--	--	50	--	**50**
ELM401	**Mini Project - 1B**	--	--	--	--	--	25	25	**50**
Total		**--**	**--**	**100**	**400**	--	**200**	**100**	**800**

Note:

1. Studentsgroupandloadoffacultyperweek.

   MiniProject 1 and2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load:1 hour per week per four groups

   MajorProject 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII – ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC401	Engineering Mathematics - IV	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC401	Engineering Mathematics - IV	20	20	20	80	03	25	--	125

Pre-requisite:

Engineering Mathematics - I, Engineering Mathematics - II,
Engineering Mathematics - III, Binomial Distribution.

Course Objectives: The course is aimed;

1. To studythe line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To study the probability distributions and expectations.
4. To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To familiarize withthe concepts of Quadratic forms and Singular value decomposition.
6. To learn the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course, learner will be able to;

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module No.	Detailed Contents	Hrs.
01	**Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate realintegrations, Z-Transform.	7
02	**Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Probability Distributions** 3.1. Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Linear Algebra: Vector Spaces** 4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence andIndependence, QR decomposition.	6

05	**Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7
06	**Calculus of Variations:** 6.1 Euler- Lagrange equation(Without Proof), When F does not contain y, When F does not contain x, When F contains x,y,y'. 6.2 Isoperimetric problems-Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-**Brachistochrone Problem, Variational Problem,Hamilton Principle, Principle of Least action,Several dependent variables.	6
Total		**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S. Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's Outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC402	Electronic Devices & Circuits - II	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC402	Electronic Devices & Circuits - II	20	20	20	80	03	--	--	100

Pre-requisite :

- **ELC302:** Electronic Devices and Circuits - I

Course Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic devices and circuits.
2. To perform DC and AC analysis of single stage and multistage amplifiers.
3. To design electronic circuits using semiconductor devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Students will be able to understand performance of amplifiers with the help of frequency response.
2. Students will be able to perform DC and AC analysis of single stage and multistage amplifiers, oscillators differential amplifiers and power amplifiers.
3. Students will be able to derive expression for performance parameters in terms of circuit and device parameters.
4. Student will be able to select appropriate circuit for given specifications/applications.

Module No.	Unit No.	Contents	Hrs.
1		**Frequency Response of Amplifiers**	7
	1.1	Low frequency response and analysis: Effect of coupling, bypass and load capacitances on single stage MOSFET amplifiers.	
	1.2	High frequency response and analysis: Effect of parasitic capacitances on MOSFET amplifiers. High frequency equivalent circuit of MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth.	
2		**Frequency Response of Multistage Amplifiers**	7
	2.1	Types of coupling. Low, mid and high frequency response and analysis of multistage amplifiers (CS-CS, CS-CG).	
3		**Feedback Amplifiers**	5
	3.1	Types of negative feedback, block diagram representation, Effect of negative feedback on Input impedance, Output impedance, Gain and Bandwidth with derivation, feedback topologies (Introduction only).	
	3.2	Analysis of voltage series negative feedback with appropriate circuits.	
4		**Oscillators**	4
	4.1	Positive feedback and principle of oscillations, RC oscillators: Phase shift oscillators, Wien bridge oscillators, LC Oscillators: Hartley and Colpitts. Crystal Oscillator (MOSFET circuit analysis).	
5		**Differential Amplifiers**	8
	5.1	MOSFET current sources, Cascode current mirror, advanced MOSFET active load, small signal analysis: MOSFET active load.	
	5.2	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, differential and common mode input impedances. MOSFET differential amplifier with active load.	
6		**Power Amplifiers**	8
	6.1	Power MOSFETs, Heat Sinks, Class A, Class B, Class C and Class AB operation, Power efficiency.	
	6.2	Class AB output stage with diode biasing, VBE multiplier biasing, input buffer transistors, Darlington configuration.	
	Total		**39**

Text Books:

1. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition.
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar,” Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.

Reference Books:

1. Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will beasked.
4. Remaining questions will be selected from all themodules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC403	Microcontroller Applications	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC403	Microcontroller Applications	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ELC302: Electronics Devices and Circuits –I
2. ELC303: Digital Logic Circuits

Course Objectives:

1. To study the Architecture, Memory and hardware features of the 8051 microcontroller.
2. To study Assembly and C language programming for 8051.
3. To study interfacing of various I/O devices.
4. To build a microcontroller-based system.

Course Outcomes:

After successful completion of the course students will be able to:

1. To explain fundamental concepts of microcontrollers.
2. To develop programming skills for microcontrollers using Assembly and C concepts
3. To interface various devices to the microcontroller
4. To design and implement microcontroller-based systems.

Module No.	Unit No.	Contents	Hrs.
1		**8051 Microcontroller Architecture**	06
	1.1	Introduction to the concepts of Microprocessors and Microcontrollers	
	1.2	Prerequisites: Concept of Buses, Read/write operations, T state, Machine cycle and Instruction cycle	
	1.3	8051 Architecture	
	1..4	8051 Memory organisation	
	1.5	RISC and CISC Concepts, Harvard and Von Neumann Architectures	
	1.6	Overview of various available Microcontrollers	
	1.7	Applications of Microcontrollers	
2		**8051 Assembly language programming**	06
	2.1	Addressing modes of 8051.	
	2.2	Assembler Directives	
	2.3	Instruction Set: Data transfer instructions, Arithmetic instructions, Logical instructions, Branching instructions.	
3		**8051 Internal Hardware**	07
	3.1	I/O ports and programming	
	3.2	Timers/Counters and programming	
	3.3	Serial port and programming	
	3.4	Interrupts and programming	
	3.5	Low power modes of the 8051	
4		**8051 programming in Embedded C**	06
	4.1	Embedded C-programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines.	
	4.2	Embedded C programming for 8051 (including programming I/O ports, Timers/Counters, Serial port and Interrupts)	
5		**8051 Interfacing –Part 1**	07
	5.1	Interfacing external memory to 8051	
	5.2	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display.	
	5.3	Keyboard interfacing: 4x4 matrix keyboard	
		(Interfacing examples must be done using Assembly language & Embedded C)	
6		**8051 Interfacing –Part 2**	07
	6.1	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)	
	6.2	Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor.	
	6.3	8051 Microcontroller based system design (including Sensors and Actuators)	
	(Interfacing examples must be done using Assembly language & Embedded C)		
		Total	**39**

Text Books:

1. M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay,"The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, Third Edition, 2005.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.
3. Ajay V Deshmukh, "Microcontroller Theory And Applications ", Tata Mcgraw Hill, 2017

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Term Work	Practical or Oral	Total
ELC404	Principles of Communication Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC404	Principles of Communication Engineering	20	20	20	80	3	--	--	100

Prerequisite:

- **Engineering Mathematics - III**
- **Engineering Mathematics - IV**

Course Objectives:

1. Understand the need for various analog modulation techniques
2. Analyze the characteristics of the receivers
3. Understand pulse modulation methods
4. Identify the necessity of multiplexing

Course Outcomes:

After successful completion of the course students will be able to:

1. describe the various elements of communication system.
2. recognize the need for multiplexing techniques.
3. analyze the performance of different analog modulation methods.
4. illustrate generation and detection of amplitude and frequency modulated systems.
5. characterize pulse modulation techniques.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Electronic Communication**	04
	1.1	**Introduction:** Electromagnetic frequency spectrum, concepts of wave propagation-ground wave, sky wave and space wave	
	1.2	**Elements of communication systems:** Information sources, communication channels, noise, sources of noises, need for modulation, bandwidth and power trade-off.	
2		**Amplitude Modulation and demodulation**	10
	2.1	**Amplitude Modulation:** Types of Analog Modulation, Principles of Amplitude Modulation, AM for a Complex Modulating Signal, AM Power Distribution, AM Current Distribution, Limitations of AM, AM modulators and Demodulator	
	2.2	**Types of AM**: Modulation & Demodulation Techniques: DSB-SC, SSB-SC, Comparison of AM, DSBSC and SSB	
	2.3	**Applications of AM:**AM Radio broadcasting, TV broadcasting of video	
3		**Angle modulation and demodulation**	09
	3.1	**Frequency Modulation:** Principles of Angle Modulation, Theory of FM— Basic Concepts, Spectrum Analysis of FM Wave, Narrowband and Wideband FM, Noise triangle, Pre-emphasis, de-emphasis FM Generation: Direct methods and Indirect method, FM Detection: Frequency discriminator and Phase discriminator methods	
	3.2	**Phase Modulation**: Theory of Phase Modulation, Relationship between FM and PM, Advantages and Disadvantages of Angle Modulation, Comparison of AM, FM and PM	
	3.3	**Applications of FM:** FM Radio broadcasting, TV broadcasting of sound	
4		**Radio Transmitters and Receivers**	06
	4.1	**Radio receivers:** Receiver Characteristics: Sensitivity, Selectivity, Fidelity, Image frequency rejection ratio, TRF Receivers and its characteristics, Concept of Heterodyning, Superheterodyne Receiver, choice of Intermediate frequency	
	4.2	**AM and FM Transmitters and Receivers**: AM and FM Radio Transmitters, AM and FM Radio Receivers, Practical diode detector, Automatic Gain Control (AGC), Types of AGC, Automatic Frequency Control (AFC) and Importance of Limiter	
5		**Pulse-Modulation and Multiplexing**	10
	5.1	**Introduction to digital transmission of signals**: comparison of Digital Analog Transmissions, Concept of regenerative Repeater	
	5.2	**Sampling and quantization**: Sampling Theorem, Aliasing error, Natural Sampling, Flat top sampling, Quantization of Signals	
	5.3	**Pulse Modulation Techniques**: Generation and detection of Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)	
	5.4	**PCM and Multiplexing**: Pulse-Code Modulation (PCM), Significance of Companding for voice signals, Delta Modulation, Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM)	
Total			**39**

Text Books:

1. Kennedy and Davis, “Electronics Communication System”, Tata McGrawHill, Fourth Edition
2. T L Singal, “Analog and Digital Communication”, Tata McGrawHill
3. B.P. Lathi, “Modern Digital and analog Communication System”, OXFORD, Fourth Edition

Reference Books:

1. Wayne Tomasi, “Electronics Communication Systems”, Pearson Education, Fifth Edition
2. Taub and Schilling, “Principles of Communication Systems”, Tata McGraw Hill, Fourth Edition
3. Roy Blake, “Electronics Communication System”, Thomson learning, Second Edition
4. R P Singh & Sapre, “Analog and Digital communication”, Tata McGraw Hill, Third Edition
5. Robert J. Schoenbeck, “Electronics communications modulation and transmission”, Second Edition
6. Lean W Couch, “Digital and Analog communication system”, Pearson Education, Sixth Edition
7. Roddy Coolen, “Electronic Communications”, PHI, Fourth Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20marks.
2. The students need to solve total 4questions.
3. Question No. 1 will be compulsory and based on entiresyllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELC405	Signals and Systems	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELC405	Signals and Systems	20	20	20	80	03	25	--	125

Course Pre-requisites:

- Basic knowledge of - Integration, Differentiation, Complex Numbers, Partial Fractions
- Basics of Laplace transform, Fourier transform and Z transform (Engineering Mathematics - I, II & III)

Course Objectives:

1. To introduce the mathematical concepts of continuous and discrete time signals and systems.
2. To acquaint the students with various time domain and frequency domain methods for analysis of signals and systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Identify and differentiate between continuous and discrete time signals and systems.
2. Develop input output relationship for LTI systems.
3. Apply the concept of Laplace transform and understand conversion from time domain to frequency domain for continuous time systems.
4. Apply the concept of Z transform and comprehend conversion from time domain to frequency domain for discrete time systems.
5. Analyse continuous time signals using Fourier series.
6. Analyse discrete time signals using Fourier Transform.

Module No.	Unit No.	CONTENTS	Hrs.
1		**Continuous and Discrete Time Signals and Systems**	8
	1.1	Mathematical Representation and Classification of Continuous Time CT) and Discrete Time (DT) Signals Arithmetic Operations on Signals, Time Shifting, Time Scaling, Time Reversal of Signals, Sampling Theorem and Aliasing	
	1.2	Mathematical Representation and Classification of CT systems	
	1.3	Mathematical Representation and Classification of DT systems	
2		**Time Domain Analysis of Continuous And Discrete Signals and Systems**	7
	2.1	Properties of Linear Time Invariant (LTI) systems, Impulse and Step Response	
	2.2	Use of Convolution Integral and Convolution Sum and Correlation for Analysis of LTI Systems	
	2.3	Properties of Convolution Integral/Sum	
3		**Frequency Domain Analysis of Continuous Time System using Laplace Transform**	6
	3.1	Need of Laplace Transform, Review of Laplace Transform, Concept of ROC, Properties, Inverse Laplace Transform, Poles and Zeros	
	3.2	Analysis and characterization of LTI system using Laplace transform: impulse and step response, causality, stability, stability of causal system	
4		**Frequency Domain Analysis of Discrete Time System using Z Transform**	6
	4.1	Need for Z Transform, Definition, Properties of Unilateral and Bilateral Z Transform, Mapping with s Plane, Relationship with Laplace Transform	
	4.2	Z Transform of Standard Signals, ROC, Poles and Zeros of Transfer Function, Inverse Z Transform	
	4.3	Analysis and Characterization of LTI System Using Z Transform: Impulse and Step Response, Causality, Stability in z-Domain.	
5		**Frequency Domain Analysis of Continuous Time Signals**	6
	5.1	Fourier Series of Continuous Time Signals ,Properties of Fourier series	
	5.2	Fourier Transform, Properties of Fourier Transform, Fourier Transform of Standard Signals, Relationship Between Fourier and Laplace Transform	
6		**Frequency Domain Analysis of Discrete Time Signals**	6
	6.1	Concept of Discrete Time Fourier Series, Properties of DTFS , Discrete Time Fourier Transform and Determination of Magnitude and Phase Functions using DTFT	
	6.2	Relation between Z transform and DTFT	
	Total		**39**

Text Books:

1. Tarun Kumar Rawat, “Signals and Systems”, Oxford University Press, 2016.
2. A. Nagoor Kani, “Signals and Systems”, Tata McGraw-Hill Education, 2014.

Reference Books:

1. John Proakis and Dimitris Monolakis, “Digital Signal Processing”, Pearson Publications, 4th Edition, 2006.
2. Alan V. Oppenheim, AlanS. Willsky, and S.Hamid Nawab, “Signals and Systems”, 2nd Edition, PHI learning, 2010
3. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2nd Edition, 2006.

Internal Assessment (IA):

Two tests must be conducted, which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus, wherein sub questions of 2 to 5 marks will be asked.
4. The remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL401	Electronic Devices & Circuits - II Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL401	Electronic Devices & Circuits - II Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of **ELC 402** (Electronic Devices and Circuits-II) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Hardware Experiment Name
1	To implement single stage MOSFET amplifier (CS) and study its frequency response
2	To implement Cascode amplifier and study its frequency response.
3	To determine input and output impedance of amplifier with and without feedback.
4	To Implement two stage RC coupled CE amplifier and plot frequency response.
5	To perform an experiment to study performance of RC phase shift oscillator.

6	To perform an experiment to study performance of Hartley oscillator.
7	To perform an experiment to study performance of Colpitts oscillator.
8	To perform an experiment to study performance of Crystal oscillator.
9	To perform an experiment to study Class B push pull amplifier.
10	To perform an experiment to study Class AB amplifier.

Suggested Simulation Experiments:

Sr. No.	Simulation Experiment Name
1	SPICE simulation of frequency response of single stage CS MOSFET amplifier.
2	SPICE simulation of frequency response of Cascade amplifier.
3	SPICE simulation of frequency response of two stage RC coupled CS amplifier.
4	SPICE simulation of RC phase shift oscillator.
5	SPICE simulation of Wein Bridge oscillator.
6	SPICE simulation of Hartley oscillator.
7	SPICE simulation of Colpitts oscillator.
8	SPICE simulation of Crystal oscillator.
9	SPICE simulation of Class B push pull amplifier.
10	SPICE simulation of Class AB amplifier.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL402	Microcontroller Applications Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL402	Microcontroller Applications Lab	--	--	--	--	--	25	25	50

Prerequisite: C Programming

Course Objectives:

1. To study Assembly and C language programming for 8051.
2. To study interfacing of various I/O devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. To develop programming skills for microcontrollers using Assembly and C concepts
2. To interface various devices to the Microcontroller

Term Work:

At least 10 experiments covering entire syllabus of **Microcontroller Applications (ELC403) s**hould be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment title
1	Arithmetic Operations
2	Logical Operations
3	Branching operations
4	I/O port programming
5	Applications of Timers
6	Serial port programming
7	Interrupts programming
8	Seven Segment Display Interfacing
9	LCD Interfacing
10	Interfacing a Matrix keyboard
11	Interfacing a Relay
12	Sensor interfacing using an ADC
13	Generation of different waveforms using DAC
14	Speed Control of DC Motor (using PWM)
15	Stepper Motor Interfacing
Atleast 05 exeperiments must be performed using Embeded C and experiments should have mix i.e. Hardware and simulation ones.	

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ELL403	Principles of Communication Engineering Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ELL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50

Term Work:

At least 10 experiments covering entire syllabus of ***ELC 404*** (Principles of Communication Engg.) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of experiments/Tutorials:

Sr. No.	Tutorial/Experiment Title
1	Tutorial on Signal Representations- Fourier Series
2	Tutorial on Signal Representations- Fourier Transforms
3	Amplitude Modulation and demodulation
4	DSB-SC BalancedModulator
5	Frequency Modulation and Demodulation

6	Super-heterodyne radio receiver
7	Pulse Amplitude Modulation, Pulse Width Modulation and Pulse Position Modulation
8	Verification of SamplingTheorem
9	Pulse Code Modulation
10	Delta Modulation and Adaptive Delta Modulation

List of Simulation/Software Experiments

Sr. No.	Simulation Experiments Name
1	Simulation of Generation of Signals
2	Simulation of Fourier Transform
3	Simulation of PSD of a Signal
4	Simulation of Multiplexing (TDM/FDM)
5	Simulation of Amplitude Modulation and Demodulation
6	Simulation of Frequency Modulation and Demodulation
7	Simulation of Phase Modulation and Demodulation

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELL 404	Skill-Base Lab: *Python Programming*	--	01$ + 03	--	--	02	--	02
$ One-hour theory per week for the complete class. (For simplifying its implementation, 2hrs. theory on alternate weeks can be conducted)								

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELL404	Skill-Base Lab: *Python Programming*	--	--	--	--	--	50	--	50

Course pre-requisite:

ECL 304 – Skill Lab: C++ and Java Programming

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to;

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object-oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python.

Module No.	Unit No.	Content	Hrs.
1		**Introduction to Python**	06
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python.	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements.	
2		**Functions and File I/O Handling**	06
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, with keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3		**Object Oriented Programming**	08
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4		**Graphical User Interface and Image processing**	08
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen	

		values and Eigen Vectors, Statistic, Weave and IO.	
6		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor	
	6.5	Support Vector Machines	
Total			48

Text Books:

1. Yashvant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1st edition (8 July 2019).
2. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher, August 2015.
3. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education

Reference books:

1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1st edition (8 December 2015).
2. Paul Barry, "Head First Python" O′Reilly; 2nd edition (16 December 2016)
3. Zed A. Shaw, "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly
4. Beautiful World of Computers and Code", Addison Wesley; 3rd edition (1 October 2013).
5. Andreas C. Mueller, "Introduction to Machine Learning with Python", O'Reilly; 1st edition (7 October 2016)
6. David Beazley, Brian K. Jones, "Python Cookbook: Recipes for Mastering Python 3", O'Reilly Media; 3rd edition (10 May 2013).
7. Bhaskar Chaudhary, "Tkinter GUI Application Development Blueprints: Master GUI
8. Programming in Tkinter as you design, implement, and deliver 10 real world application", Packt Publishing (November 30, 2015)

Software Tools:

- Python IDE: https://www.python.org/downloads/
- Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

Sr. No.	Problem Statement	Module No.
1	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). 5. Write a program to convert and print this distance in meters, feet, inches and centimeter. 6. Write a program to carry out the following operations on the given set 7. s = {10, 2, -3, 4, 5, 88} a) Number of items in sets s b) Maximum element in sets s c) Minimum element in sets s d) Sum of all elements in sets s e) Obtain a new sorted set from s, set s remaining unchanged f) Report whether 100 is an element of sets s g) Report whether -3 is not an element of sets s.	Module 1
2	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. 3. Generate and print a list of tuples containing name, age and salary from the 3 lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4	Module 3

	decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number enteredthrough the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write arecursive function to calculate sum of digits of 5-digit number.	
4	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain a. individual histograms. 4. Write Python program for histogram equalization 5. Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a) Find and print the name of the country with the highest GDP b) Find and print the name of the country with the lowest GDP c) Print text and input values iteratively d) Print the entire list of the countries with their GDPs e) Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a) View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, fatal flag b) Clean the dataset and replace the fatal flag NaN with “No”. c) Find the aircraft types and their occurrences in the dataset d) Remove all the observations where aircraft names are not available e) Display the observations where fatal flag is “Yes” 5. Analyze the “auto mpg data” and draw a pair plot using seabornlibrary for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous	Module 5

	• horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 6. Write python program to use SciPy to solve a linear algebraproblem. 7. There is a test with 30 questions worth 150 marks. The test has twotypes of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

Suggested List of Experimentsand problem statements are indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least 12 experiments and 1 course project should be performed. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Credits
ELM 401	Mini Project - 1B	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELM 401	Mini Project - 1B	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book: 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on the following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

AC05.05.2018
Item No. 4.54

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. Themajor challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards.The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Electronics Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Electronics Engineering. The Program Educational Objectives finalized for the undergraduate program in Electronics Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr.Sudhakar S. Mande

Chairman, Board of Studies in Electronics Engineering, University of Mumbai

T.E. (Electronics Engineering) – Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX501	Microcontrollers and Applications	04	--	---	04	---	---	04
ELX 502	Digital Communication	04	-	--	04	---	---	04
ELX 503	Engineering Electromagnetics	04	-	@01	04	---	01	05
ELX 504	Design with Linear Integrated Circuits	04	02	---	04	---	---	04
ELX 505	Business Communication & Ethics	02	02#		---	02	---	02
ELXDLO501X	Department Level optional courses I	04	02	---	04		---	04
ELXL501	Microcontrollers and Applications Lab.					01	---	01
ELXL502	Digital Communication Lab.					01	---	01
ELXL503	Design with Linear Integrated Circuits Lab.					01	---	01
ELX DLOl50X	Department Level optional course-I Lab					01	---	01
	TOTAL	**20**	**08**	**04**	**20**	**06**	**01**	**27**

1 hour tutorial class-wise #02 hours batch-wise

Course Code	Course Name	Examination Scheme – Semester V							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX501	Micro-controllers and Applications	20	20	20	80	03	---	---	100
ELX 502	Digital Communication	20	20	20	80	03	---	---	100
ELX 503	Engineering Electromagnetics	20	20	20	80	03	25	---	125
ELX 504	Design with Linear Integrated Circuits	20	20	20	80	03	---	---	100
ELX 505	Business Communication & Ethics	---	---	---	---	---	50	---	50
ELX DLO501X	Department Level Elective-I	20	20	20	80	03	---	---	100
ELXL501	Micro-controllers and Applications Lab.						25	25	50
ELXL 502	Digital Communication Lab.						25	---	25
ELXL 503	Design with Linear Integrated Circuits Lab.						25	25	50
ELXL DLO501X	Department Elective I lab						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**175**	**75**	**750**

Course Code	Department Level Optional Course I
ELXDLO5011	Database and Management System
ELXDLO5012	Digital Control system
ELXDLO5013	ASIC Verification
ELXDLO5014	Biomedical Instrumentation

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 501	Microcontrollers and Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dura-tion (hrs)					
		Test 1	Test 2	Avg.							
ELX 501	Microcontrollers &Applications	20	20	20	80	03	--	--	-	--	100

Course Code	Course Name	Credits
ELX 501	Microcontrollers and Applications	04
Course Objectives	To study 8-bit microcontroller architecture for system design along with exposure to advanced 32-bit architecture.	
Course Outcomes	1. Explain 8051 microcontroller architecture. 2. Develop assembly language programmes for 8051 microcontroller. 3. Design and implement 8051 based systems. 4. Explain advanced features of Cortex-M3 architecture.	

Module		Contents	Time
1.		**8051 Microcontroller Architecture**	04
	1.1	Introduction to microcontroller.	
	1.2	Overview of MCS51 family.	
	1.3	8051 architectural features.	
	1.4	Memory organisation.	
2.		**8051 Microcontroller assembly language programming**	10
	2.1	Addressing modes of 8051.	
	2.2	Instruction Set: Data transfer, Arithmetic, Logical, Branching.	
	2.3	Assembly Language Programming.	
3.		**8051 Internal Hardware & Programming**	10
	3.l	I/O port structure and programming.	
	3.2	Interrupts and programming.	
	3.3	Timer/Counter and programming.	
	3.4	Serial port and programming.	
4.		**8051 Interfacing & Applications**	12
	4.1	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric	

		LCD display.	
	4.2	Keyboard interfacing: 4x4 matrix keyboard.	
	4.3	Analog devices interfacing: 8-bit ADC/DAC, temperature sensor (LM35).	
	4.4	Motor interfacing: Relay, dc motor, stepper motor and servo motor.	
5.		**ARM CORTEX-M3 Architecture**	**12**
	5.1	Comparison of CISC & RISC architectures, overview of ARM family.	
	5.2	ARM Cortex-M3 architecture, Programmer's model: Operation Modes and States, registers, special registers, Application Program Status Register-Integer status flags, Q status flag, GE bits.	
	5.3	Memory system: Features and memory map	
	5.4	Exceptions and Interrupts-Nested vectored interrupt controller	
		Total	**48**

Text books:

1.M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay,"The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd Edition.

2.Joseph Yiu,"The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books:

1.Kenneth J. Ayala,"The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rdEdition.

2.David Seal, "ARM Architecture", Reference Manual (2nd Edition), Publisher Addison Wesley.

3.Andrew Sloss, Dominic Symes, Chris Wright,"ARMSystem Developers Guide: Designing and Optimising System Software", Publisher Elsevier Inc. 2004.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.
4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 502	Digital Communication	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 502	Digital Communication	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering

Course Objectives:

The objectives of this course are to:

1. Understand the typical subsystems of a digital communication system
2. Understand the significance of the trade-off between SNR and Bandwidth
3. Understand the effect of ISI in Baseband transmission of a digital signal.
4. Analyze various Digital modulation techniques
5. Identify the necessity of Source encoding and Channel encoding in Digital communication

Course Outcomes:

On successful completion of the course the students will be able to:

1. Comprehend the advantages of digital communication over analog communication and explain need for various subsystems in Digital communication systems
2. Realize the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3. Understand the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect
4. Analyze various Digital modulation methods and assess them based on parameters such as spectral efficiency , Power efficiency, Probability of error in detection
5. Explain the concept and need for designing efficient Forward Error Correcting codes.
6. Realize the areas of application of Digital communication.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Digital communication system:**	06
	1.1	A typical Digital communication system, Advantages and disadvantages of Digital transmission, significance of digitization: PCM encoding of voice and image signals.	
	1.2	**Concept of Probability Theory in Communication Systems:** Random variables, Mean and Variance of Random variables and sum of random variables ,Definition with examples,	
	1.3	**Useful PDFs & CDFs** :Gaussian, Rayleigh pdf & Rician Distribution, Binomial Distribution, Poisson Distribution, Central-Limit Theorem, Binary Synchronous Channel(BSC), development of Optimal receiver	
2.		**Information Theory and Source Coding**	06
	2.1	Measure of Information, Entropy, Information rate, Channel capacity, Shannon – Hartley Capacity Theorem and its Implications.	
	2.2	Shannon-Fano encoding, Huffman encoding , Code Efficiency & Redundancy.	
3.		**Pulse Shaping for Optimum Transmission:**	08
	3.1	Line codes and their desirable properties, PSD of digital data	
	3.2	Baseband PAM transmission: Concept of Inter symbol interference(ISI),Raised Cosine filter , Nyquist Bandwidth. Concept of equalizer to overcome ISI	
	3.3	Correlative coding: Duo-binary encoding and modified duo-binary encoding	
4.0		**Digital Modulation Techniques**	14
	4.1	Concept of Binary and M-ary transmission, Coherent and Non- Coherent reception, Power spectral density of Pass-band signal, Signal space Representation and Euclidian distance	
	4.2	Pass Band Amplitude modulation & Demodulation: BASK , M-ary PAM ,Digital Phase Modulation & Demodulation: BPSK, OQPSK, QPSK, M-ary PSK, QAM , Digital Frequency Modulation &Demodulation :BFSK, MSK , M-ary FSK	
	4.3	Comparison of all techniques based on Spectral efficiency, Power efficiency, Probability of error in detection	
	4.4	**Optimal Reception of Digital Data**: A baseband signal receiver and its Probability of error, The Optimum receiver, Matched filter, & its properties.	
5.0		**Error Control codes:**	10
	5.1	Need for channel encoding, Concept of Error detection and correction , Forward Error	

		correction	
	5.2	**Linear block codes** : Hamming Distance, Hamming Weight, Systematic codes ,Syndrome Testing	
	5.3	**Cyclic codes**; Generator polynomial for Cyclic codes, Systematic cyclic codes, Feedback shift register for Polynomial division	
	5.4	**Convolution codes**: Convolution encoder , Impulse response of encoder, State diagram, trellis diagram Representations	
6.0		**Applications of Digital communication**	**06**
	6.1	**Satellite communication system** : Satellite communication System model, Transponder ,Satellite Orbits : LEO, MEO, GEO , Link analysis	
	6.2	**Optical Communication system** : Advantages of Optical communication ,Signal transmission in Optical fibres, Optical sources and Optical Detectors, Optical Digital Communication system.	
		Total	**48**

Recommended Text Books:

1. Simon Haykin, "*Communication System*", John Wiley And Sons ,4th Ed
2. Taub Schilling & Saha, "*Principles Of Communication Systems*", Tata Mc-Graw Hill, Third Ed
3. B P Lathi & Zhi Ding ,"*Modern Digital and Analog communication systems" -4E,* Oxford University Press , Indian Ed.
4. R N Mutagi, "*Digital Communication"*, Oxford University Press, 2nd Ed.

Reference Books:

1. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
2. Simon Haykin, "Digital communication", John wiley and sons
3. PROAKIS & SALEHI, "Communication system Engineering", Pearson Education.
4. Anil K.Maini & Varsha Agarwal, "Satellite communications", Wiley publication.
5. Amitabha Bhattacharya, "*Digital Communication*", Tata Mcgraw Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX503	Electromagnetic Engineering	20	20	20	80	--	--	--	100

Course Objectives:

1. To study correlation between electrostatics, steady magnetic field and time varying fields using Maxwell's equations for different media.
2. To calculate energy transported by means of electromagnetic waves from one point to another and to study polarization of waves.
3. To solve electromagnetic problems using different numerical methods.
4. To extend the students' understanding about the propagation of the waves of different types.
5. To understand the radiation concepts.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze the behaviour of electromagnetic waves in different media.
2. Evaluate various parameters of transmission lines and radiating systems.
3. Apply computational techniques to analyze electromagnetic field distribution.
4. Understand different mechanisms of radio wave propagation.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Laws of Electromagnetic and Maxwell's Equations**	10
	1.1	Coulomb's law, Gauss's law, Bio-Savart's law, Ampere's law, Poisson's and Laplace equations	
	1.2	**Maxwell's Equations:** Integral and differential form for static and time varying fields and its interpretations	
	1.3	Boundary conditions for Static electric and magnetic fields	
2.0		**Electromagnetic Waves**	12
	2.1	Wave Equation and its solution in partially conducting media(lossy dielectric), perfect dielectrics, free space and good conductors, Skin Effect and concept of Skin depth	
	2.2	**Polarization of wave:** Linear, Circular and Elliptical	
	2.3	**Electromagnetic Power:** Poynting Vector and Power Flow in free space, dielectric and conducting media	
	2.4	**Propagation in different media:** Behavior of waves for normal and oblique incidence in dielectrics and conducting media, propagation in dispersive media	

3.0		**Computational Electromagnetics**	**06**
	3.1	**Finite Difference Method (FDM):** Neumann type and mixed boundary conditions, Iterative solution of finite difference equations, solutions using band matrix method	
	3.2	**Finite Element Method (FEM**): triangular mesh configuration, finite element discretization, element governing equations, assembling all equations and solving resulting equations	
	3.3	**Method of Moment (MOM):** Field calculations of conducting wire	
4.0		**Fundamentals of Radiating Systems**	**06**
	4.1	Concept of retarded potentials, Lorentz Condition	
	4.2	Radiation from an alternating current element, half-wave dipole and quarter-wave monopole	
	4.3	**Antenna Parameters:** Radiation Patterns, beam-width, Radiation intensity, directivity, power gain, band-width, radiation resistance and efficiency, effective length and effective area	
5.0		**Radio wave propagation**	**06**
	5.1	**Types of wave propagation:** Ground, space, and surface wave propagation	
	5.2	**Space wave propagation:** Effect of imperfection of earth, curvature of earth, effect of interference zone, Line of sight propagation, troposphere propagation and fading	
	5.3	**Sky wave propagation:** Reflection and refraction of waves, structure of Ionosphere	
	5.4	**Measures of ionosphere propagation:** Critical frequency, Angle of incidence, Maximum usable frequency, Skip distance, Virtual height	
6.0		**Transmission Lines**	**08**
	6.1	Transmission Line parameters and equivalent circuit Transmission line equation and solution	
	6.2	**Secondary Parameters:** Propagation constant, characteristic impedance, reflection and transmission coefficient, Input Impedance, SWR, introduction to Smith chart	
		Total	**48**

Recommended Books:

1. W.H. Hayt, and J.A. Buck, "*Engineering Electromagnetics*", McGraw Hill Publications, 7th Edition, 2006
2. R.K. Shevgaonkar, "*Electromagnetic Waves*", TATA McGraw Hill Companies, 3rd Edition, 2009
3. Edward C. Jordan and Keth G. Balmin, "*Electromagnetic Waves and Radiating Systems*", Pearson Publications, 2nd Edition, 2006
4. Matthew N.D. Sadiku, "*Principles of Electromagnetics*", Oxford International Student 4th Edition, 2007
5. J.D. Kraus, R.J. Marhefka, and A.S. Khan, "*Antennas & Wave Propagation*", McGraw Hill Publications, 4th Edition, 2011

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pract	Tutorial	Total
ELX504	Design with Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks							
		Internal assessment							
		Test 1	Test 2	Avg. of Test 1 and Test 2	End Sem. Exam	Term Work	Prac.	Oral	Total
ELX504	Design with Linear Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Electronic Devices and Circuits I and II

Course Objectives:

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate an understanding of fundamentals of integrated circuits.
2. analyze the various applications and circuits based on particular linear integrated circuit.
3. select and use an appropriate integrated circuit to build a given application.
4. design an application with the use of integrated circuit

Module No.	Unit No.	Topics	Hrs.
1	**Fundamentals of Operational Amplifier**		04
	1.1	Ideal Op Amp, characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, practical determination of op-amp parameters, single supply versus dual supply op-amp	
	1.2	Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier	
2	**Applications of Operational Amplifier**		12
	2.1	**Amplifiers:** Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier and application of Op-Amp in Transducer Measurement System with detail design Procedure. Single supply dc biasing techniques for inverting, non inverting and differential amplifiers.	
	2.2	**Converters:** Current to voltage converters, voltage to current converters, generalized impedance converter	
	2.3	**Active Filters:** First order filters, Second order active finite and infinite gain low pass, high pass, band pass and band reject filters.	

	2.4	**Sine Wave Oscillators:** RC phase shift oscillator, Wien bridge oscillator, Quadrature oscillator.	
3	**Non-Linear Applications of Operational Amplifier**		10
	3.1	**Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector.	
	3.2	**Schmitt Triggers:** Inverting Schmitt trigger, non-inverting Schmitt trigger with adjustable threshold levels.	
	3.3	**Waveform Generators:** Square wave generator and triangular wave generator with duty cycle modulation**.**	
	3.4	**Precision Rectifiers:** Half wave and full wave precision rectifiers and their applications.	
	3.5	Peak Detectors, Sample & Hold Circuits, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	
4	**Data Converters**		06
	4.1	**Analog to Digital**: Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC, ADC0808/0809 and its interfacing	
	4.2	**Digital to Analog**: Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC, DAC0808 and its interfacing	
5	**Special Purpose Integrated Circuits**		08
	5.1	Functional block diagram, working, design and applications of Timer 555.	
	5.2	Functional block diagram, working and applications of VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380.	
6	**Voltage Regulators**		08
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	
		Total	**48**

Recommended Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. William D. Stanley, "*Operational Amplifiers with Linear Integrated Circuits* ", Pearson, 4th Edition
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.
4. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
5. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
6. R. P. Jain, "*Modern Digital Electronics*," Tata McGraw Hill, 3rd Edition.
7. Ron Mancini, "*Op Amps for Everyone*", Newnes, 2nd Edition.
8. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
9. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
10. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", NewYork: McGraw-Hill, Burr-Brown Research Corporation.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final internal assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory preferably objective type and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5011	Database Management System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELX DLO5011	Database Management System	20	20	20	80	--	--	--	100

Prerequisite:

Basic knowledge of Data structure.

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction Database Concepts:**	**4**
	1.1	Introduction, Characteristics of databases File system v/s Database system Users of Database system	4
	1.2	Data Independence DBMS system architecture Database Administrator	
2.0		**Entity–Relationship Data Model**	**8**
	2.1	The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation	
3.0		**Relational Model and relational Algebra**	**8**
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model	
	3.2	Relational Algebra – unary and set operations , Relational Algebra Queries.	
4.0		**Structured Query Language (SQL)**	**12**
	4.1	Overview of SQL Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands.	
	4.2	Set and string operations, aggregate function - group by, having.Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints	
	4.3	Triggers	

5.0		**Relational–Database Design**	**8**
	5.1	Pitfalls in Relational-Database designs , Concept of normalization Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF.	
6.0		**Transactions Management and Concurrency**	**12**
	6.1	Transaction concept, Transaction states, ACID properties Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols.	
	6.2	Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. Deadlock handling	
		Total	**52**

Text Books:

1. G. K. Gupta "Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, "Fundamentals of Database Systems", 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, " Introduction to Database Management", Wiley Publication.
3. Sharaman Shah, "Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems ",TMH.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5012	Digital Control Systems	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5012	Digital Control Systems	20	20	20	80	03	--	--	--	100

Course Pre-requisite: ELX301: Mathematics III , ELX401: Mathematics IV, ELX406: Linear Control Systems

Course Objectives:

1. To introduce the discrete-time systems theory.
2. To introduce Z-transform methods in digital systems design.
3. To introduce modern state-space methods in digital systems design.

Course Outcomes : At the end of the course, the learner will have the ability to

1. Justify the need for digital control systems as well as understand sampling and reconstruction of analog signals.
2. Model the digital systems using various discretization methods and understand the concept of Pulse Transfer Function.
3. Analyze the digital control systems using classical techniques.
4. Analyze the digital control systems using modern state-space techniques.
5. Understand the concept of controllability and design the state feedback controllers.
6. Understand the concept of observability and design the state observers.

Module		Contents	Time
1.		**Basics of discrete-time signals and discretization**	06
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system.	
	1.2	Impulse sampling. Nyquist-Shannon sampling theorem, reconstruction of discrete-time signals (ideal filter)	
	1.3	Realizable reconstruction methods (ZOH and FOH). Transfer function of ZOH and FOH.	
2.		**Modelling of Digital Control System**	10
	2.1	Discretization Approaches: Impulse invariance, step invariance, bilinear transformation, finite difference approximation of derivative.	
	2.2	Z-transform revision and its equivalence with starred Laplace transform.	
	2.3	The pulse transfer function (PTF) and general procedures to obtain PTF.	

3.		**Stability Analysis and Controller Design via Conventional Methods**	**12**
	3.l	Mapping between s-plane and z-plane, stability analysis of digital systems in z-plane. Effects of sampling frequency on stability.	
	3.2	Transient and steady-state analysis of time response, digital controller design using root-locus method.	
	3.3	Digital controller design using bode plots, digital PID controller.	
	3.4	Realization of digital controllers: direct programming, standard programming, series programming, parallel programming, ladder programming,	
4.		**State Space Analysis of Discrete-time Systems**	**08**
	4.1	Revision of continuous-time state-space models. Solution of continuous-time state-space equation. Discretization of continuous-time state-space solution and discrete-time state-space model.	
	4.2	Various canonical state-space forms for discrete-time systems and transformations between state-space representations.	
	4.3	Solution of discrete-time state-space equation. Computation of state-transition matrix (z-transforms, Caley-Hamilton theorem, Diagonalization).	
5.		**Controllability and State Feedback Controller Design**	**06**
	5.1	Concept of controllability. Distinction between reachability and controllability in discrete-time systems.	
	5.2	Digital controller design using pole-placement methods. (Similarity transforms, Ackerman's formula).	
6.		**Observability and Observer Design**	**06**
	6.1	Concept of observability. Distinction between detectability and observability in discrete-time systems.	
	6.2	Observer design (prediction observer and current observer). Output feedback controller design. Introduction to separation principle.	
	6.3	Dead-beat controller design, dead-beat observer design.	
Total			**48**

Text books:

1. **Ogata Katsuhiko**, "Discrete-time Control Systems", Pearson, 2nd Edition, 1995.
2. **M. Gopal**, "Digital Control and State Variable Methods", Tata McGrow-Hill, 3rd Edition, 2003.

Reference Books:

1. **Gene Franklin, J. David Powell, Michael Workman**, "Digital Control of Dynamic Systems", Addison Wesley, 3rd Edition, 1998.
2. **B. C. Kuo**, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
3. **Chi-Tsong Chen**, "Linear System Theory and Design", Oxford University Press, USA, 1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5013	ASIC Verification	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory					Term work	Pract.	Oral	Total
		Internal Assessment			End sem	Duration (hrs)				
		Test 1	Test 2	Avg						
ELX DLO5013	ASIC Verification	20	20	20	80	03	--	--	--	100

Course Pre-requisite: EXC303: Digital Circuits and Design, ELXL304: Object Oriented Programming Methodology Laboratory, ELX 404: Digital System Design

Course Objectives

1. To introduce the learner System Verilog concepts for verification.
2. To introduce the learner advanced verification features such as practical use of classes, randomization, checking and coverage.
3. To highlight the significance of verification in VLSI industry.

Course Outcomes

At the end of the course, the learner will have the ability to

1. Demonstrate an understanding of programmable devices and verification methodologies.
2. Exploit new constructs in SV and advanced ASIC verification techniques.
3. Create test benches for digital designs in system verilog.
4. Carry out verification of design successfully using simulators

Module		Contents	Time
1.		**Programmable Devices and Verilog**	08
	1.1	**Programmable Devices:** Architecture of FPGA, CPLD with an example of Virtex-7 and Spartan -6 family devices	
	1.2	**Verilog HDL:** Data types, expressions, assignments, behavioural, gate and switch level modelling, tasks and functions	
2.		**Verification Basics and Data Types**	12
	2.1	**Verification Basics:** Technology challenges, Verification methodology options, Test bench creation, test bench migration, Verification languages, Verification IP reuse, Verification approaches, Layered Testbench, Verification plans	
	2.2	**Data Types:** Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user defined structures, type conversion, enumerated types, constants, strings, expression width	

3.		**Procedural statements, test bench and Basic OOP**	**12**
	3.1	**Procedural Statements and Routines:** Procedural statements, tasks, functions and void functions, task and function overview, routine arguments, returning from a routine, local data storage, time values **Connecting the Test bench and Design:** Separating the test bench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, top level scope, program-module interactions	
	3.2	**Basic OOP:** Class, Creating new objects, Object deal location, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public vs. local, building a test bench	
4.		**Randomization and IPC**	**10**
	4.l	**Randomization:** Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques	
	4.2	**Threads and Inter process Communication:** working with threads, disabling threads, inter process communication, events, semaphores, mailboxes, building a test bench with threads and IPC	
5.		**Assertions and Functional Coverage**	**06**
	5.1	**System Verilog Assertions:** Assertions in verification methodology, Understanding sequences and properties	
	5.2	**Functional Coverage:** Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options	
		Total	**48**

Text books:

1. **Chris Spear**, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 3rd Edition.
2. **Janick Bergeron**, "Writing Testbenches Using System Verilog", Springer 2006.
3. **Stuart Sutherland, Simon Davidmann, and Peter Flake**, "System Verilog for Design:

   A guide to using system verilog for hardware design and modeling", Springer, 2nd Edition.

Reference Books:

1. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "SystemVerilog Assertions Handbook", VhdlCohen Publishing, 3rd edition
2. S Prakash Rashinkar, Peter Paterson and Leena Singh, "System on Chip Verification Methodologies and Techniques", Kluwer Academic, 1st Edition.
3. System Verilog Language Reference manual
4. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis" second edition,Pearson – IEEE 1364-2001 compliant.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO5014	Biomedical Instrumentation	04	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX DLO5014	Biomedical Instrumentation	20	20	20	80	03	--	--	--	--	100

Course Objectives

1. Introduce the learners to basic physiology and function of various systems in human body.

2. Introduce the learners to Diagnostic, Pathology, Life supportive equipment and latest imaging modalities in hospitals and healthcare industry.

3. Motivate learners to take up live projects with medical applications which will benefit the society at large.

Course Outcomes

- Have basic knowledge about the basic structure and functions of parts of cell, generation of action potential and various bioelectric potentials.
- Builds foundation of knowledge of physiological processes such as respiratory, cardiovascular, nervous and muscular systems in human body.
- Compare various methods used for measurement of various cardiac parameters such as blood pressure, blood flow, blood volume, cardiac output and heart sounds.
- Know the basic principle of analytical instruments and will have an over view of pathology laboratory equipments such as colorimeter, spectrophotometer, blood cell counter and auto-analyser.
- Have knowledge of life support equipments such as pacemaker, defibrillator, Heart lung machine, Haemodialysis machine and baby incubator along with safety limits of micro and macro shocks and understand the importance of electrical safety in hospital equipments.
  Have knowledge of imaging modalities such as X-ray, CT, MRI and Ultrasound.

Module		Contents	Time
1.		**Bio-Potential measurements**	06
	1.1	**Human Cell** Structure of Cell, Origin of Bio-potentials, Generation of Action Potentials,.	
	1.2	**Electrodes** Electrode-Electrolyte interface and types of bio-potential electrodes	
2.		**Physiological Systems and Related Measurement**	12
	2.1	**Cardiovascular system**	

		Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias, Design of ECG amplifier, Heart sounds measurement.	
	2.2	**Nervous system** CNS and PNS: Nerve cell, Neuronal Communication, Generation of EEG and its measurement. Normal and abnormal EEG, Evoked potential. Electroencephalography: EEG measurements, Electrode-placement and Block diagram of EEG machine	
	2.3	**Respiratory system** Physiology of respiration and measurements of respiratory related parameters like respiration rate, Lung Volumes and capacities	
	2.4	**Muscular system** Typical Muscle fibre Action potential Electromyography: EMG measurement and block diagram.	
3.		**Cardio-Vascular measurements**	**08**
	3.1	Blood Pressure- Direct and Indirect types.	
	3.2	Blood Flow- Electromagnetic and Ultrasonic type.	
	3.3	Blood Volume- Plethysmography: Impedance, Capacitive and Photoelectric type	
	3.4	Cardiac Output- Fick's method, Dye-dilution and Thermo-dilution type.	
4.		**Analytical equipment**	**05**
	4.1	Beer Lambert's law, Principle of photometry.	
	4.2	Photo-colorimeter : Optical diagram	
	4.3	Spectrophotometer : Optical diagram	
	4.5	Blood cell counter : Coulter’s counter	
	4.6	Auto-analyser : Schematic diagram	
5.		**Life-saving and Support equipment**	**09**
	5.1	Pacemaker- Types of Pacemaker, Modes of pacing and its applications.	
	5.2	Defibrillator-Types of fibrillations, Modes of operation, DC Defibrillators and their applications.	
	5.3	Heart-Lung machine: System-flow diagram and its Application during surgery.	
	5.4	Haemodialysis machine: Principle of operation and System-flow diagram.	
	5.5	Baby Incubator and its applications	
	5.6	**Patient safety** Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention	
6.		**Imaging techniques**	**08**
	6.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its applications	
	6.2	CT Scan- CT Number, Block Diagram, scanning system and applications.	

	6.3	MRI- Concepts and image generation, block diagram and its applications	
	6.4	Ultrasound Imaging- Modes of scanning and their applications	
		Total	**48**

Text books:

1. Handbook of Biomedical Instrumentation: R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference Books:

1.Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2.Various Instruments Manuals.
3.Various internet resources.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners need to solve total 4 questions.
Question No.1 will be compulsory and based on entire syllabus.
Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 501	Microcontrollers & Applications Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ELXL501	Microcontrollers &Applications Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 501 (Microcontrollers and Applications)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.**

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. Practical and Oral exam will be based on the entire syllabus.

Suggested experiments:

- Maximum three experiments in X – 51 assembly programming involving arithmetic, logical, Boolean, code-conversion etc operations.
- Minimum three experiments on interfacing of X – 51 based system with peripheral IC's (ADCs, DACs etc) peripheral actuators (relays, motors etc.) sensors (temperature, pressure etc.).

Suggested mini projects:

- Interfacing single LED/seven-segment display(SSD)/multiple-SSD with refreshing along-with some additional functional feature.
- Interfacing dot matrix LED for message display/ rolling message display.
- Interfacing IR emitter/receiver pair for time-period/speed calculations.
- Interfacing single key/4 – key/4 X 4 matrix keyboard with some additional functional feature.
- Motors – continuous, stepper, servo interfacing with speed(RPM) indication.
- Multi-function alarm clock using buzzer and LCD.
- Interfacing DAC and generating various waveforms.
- Ambient temperature indicator using LM 35 and 8-bit ADC 0808.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 502	Digital Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 502	Digital Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum Seven experiments need to be conducted, out of which at least THREE should be software-based

(Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work.

The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology.

("Beyond the scope of the syllabus".) Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+REPORT carry minimum of 10 marks

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested experiments based on Laboratory setups:

1. Line codes
2. Binary modulation techniques: BASK,BPSK,BFSK
3. M-ary modulation techniques: QPSK ,QAM
4. MSK

Suggested experiments based on software:

1. Simulation of PDF& CDF of Raleigh / Normal/ Binomial Distributions
2. Simulation of Eye pattern for PAM signal
3. Source encoding: Huffman coding for Binary symbols
4. Simulation of Shannon-Hartley equation to find the upper limit on the Channel Capacity
5. Channel Encoding: Linear Block code : code generation, Syndrome
6. Cyclic code-code generation, Syndrome
7. Channel encoding: Convolutional code-code generation from generator sequences
8. Simulation of BPSK/QPSK/BFSK Modulation
9. Simulation of Duo-binary encoder-decoder
10. Plot and compare BER curves for Binary/ M-ary modulation schemes
11. Simulation of error performance of a QPSK/BPSK/MSK Modulator

Suggested topics for presentation:

1. DTH
2. Digital Multiplexing
3. Satellite Launching vehicles: PSLV, GSLV
4. Digital TV
5. Digital Satellite system: VSAT
6. RFID

Any other related and advanced topics.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL503	Design With Linear Integrated Circuits Laboratory	-	2	--	-	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXL503	Design With Linear Integrated Circuits Laboratory	--	--	--	--	25	25		50

Term Work:

At least Six experiments based on the entire syllabus of Course ELX504 **(Design with Linear Integrated Circuits)** should be set to have well predefined inference and conclusion. Few computation/simulation based experiments are encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

A mini project based on the following topic or additional real time applications are encouraged. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

1. Experiment on op amp parameters
2. Experiment on design of application using op amp (Linear)
3. Experiment on implementation of op amp application e.g. oscillator

4. Experiment on non linear application (e.g. comparator) of op amp
5. Experiment on non linear application (e.g. peak detector) of op amp
6. Experiment on ADC interfacing
7. Experiment on DAC interfacing
8. Experiment on IC 555
9. Experiment on voltage regulator (Design)
10. Experiment on implementation of instrumentation system (e.g. data acquisition).
    The topic for the mini project in the course based on the syllabus of ELX505(Design with Linear Integrated Circuits)need to be application oriented.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5011	Database Management Systems Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5011	Database Management Systems Laboratory	--	--	--	--	25	--	25		50

At least **eight experiments** based on the entire syllabus of **ELXDLO5011 (Data Base Management System)** should be set to have well-defined inference and conclusion. The experiments should be student-centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) must perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	To analyse the sampling and reconstruction of analog signal.
2	To study various discretization approaches (Impulse Invariance, Step Invariance, Bilinear Transformation)
3	Study of time domain transient and steady-state performance and performance specifications.
4	Digital controller design using Root-locus method.
5	Modelling of discrete-time systems in state-space and conversion to various canonical forms.

6	Discrete-time system simulation in Simulink.
7	Study digital PID controller and its implementation in MATLAB and Simulink.
8	Controllability and Observability of discrete-time systems.
9	Pole placement controller design for discrete-time systems.
10	Design of deadbeat controller and observer.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5012	ASIC Verification	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5012	ASIC Verification	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5013 (ASIC Verification)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

List of Experiments:

1. Implementation of 4:1 Multiplexer in Verilog with
    a. Gate level Modeling
    b. Structural/ Dataflow Modeling
    c. Behavioral Modeling
2. Implementation of D flip flop (Asynchronous/ Synchronous/latch) using Verilog.
3. Experiment to practice creating dynamic arrays, associative arrays, and queues (Test a synchronous 8-bit x64K (512kBit) RAM).
4. Write a test plan and test bench for ALU Design.
5. Experiment to practice Procedural Statements and Routines using tasks, functions and do-while loops.
6. Create Interfaces to connect the Test bench and Design.
7. Threads & IPC: Implement the following counters

    i. UP counter
    ii. DOWN counter
    iii. Divide by 2 count As threads. Use Fork join, fork join_none, fork_joinany.

8. Threads & IPC - create dynamic processes (threads) and get familiar with interprocess communication using events, semaphore and mailb
9. Functional Coverage - write cover groups and get familiar with the coverage repor
   Verification of FIFO

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO5013	Biomedical Instrumentation	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg						
ELXL DLO5013	Biomedical Instrumentation	--	--	--	--	25	--	25		50

At least **eight** experiments based on the entire syllabus of **ELXDLO5014 (Biomedical Instrumentation)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed students well in advanced.

Suggested List of Experiments

Expt. No.	Title of the Experiments
1	Study of X-ray Tubes
2	Design of active notch filter for line frequency
3	Design of general purpose amplifier for Bio potential measurement.
4	Design of Pacemaker using 555 timer.
5	Demonstration of Blood pressure measurement.
6	Demonstration of Electrocardiogram recording.

7	Demonstration of Electroencephalogram recording.
8	Demonstration of Electromyogram recording.
9	Demonstration of Photo-Colorimeter.
10	Demonstration of Spectrophotometer.
11	Demonstration of Auto-analyser.
12	Demonstration of Blood Cell counter.
13	Demonstration of D C Defibrillator (proto type).
14	Demonstration of Baby Incubator.
15	Demonstration of X Ray machine.
16	Demonstration of CT scanner.
17	Demonstration of MRI machine.
18	Demonstration of Ultrasound machine.

T.E. (Electronics Engineering) – Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX601	Embedded System and RTOS	04	--	---	04	---	---	04
ELX 602	Computer Communication Network	04	--	---	04	---	---	04
ELX 603	VLSI Design	04	--	---	04	---	---	04
ELX 604	Signals and systems	04	--	@01	04	---	01	05
ELXDLO502X	Department Level Optional courses II	04	--	---	04	---	---	04
ELXL601	Embedded System and RTOS Lab.	--	02	--	--	01	---	01
ELXL 602	Computer Communication Network Lab.	--	02	--	--	01	--	01
ELXL 603	VLSI Design Lab.	--	02	--		01	---	01
ELXLDLO601X	Department Level Optional courses IILab.	--	02	--		01	---	01
TOTAL		**20**	**08**	**01**	**20**	**04**	**01**	**25**

Course Code	Course Name	Examination Scheme – Semester VI							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX601	Embedded System and RTOS	20	20	20	80	03	---	---	100
ELX 602	Computer Communication Network	20	20	20	80	03	---	---	100
ELX 603	VLSI Design	20	20	20	80	03	---	---	100
ELX 604	Signals and systems	20	20	20	80	03	25	25	100
ELXDLO602X	Department Level Optional courses II*	20	20	20	80	03	---	---	100
ELXL601	Embedded System and RTOS Lab.						25	25	50
ELXL 602	Computer Communication Network Lab.						25	25	50
ELXL 603	VLSI Design Lab.						25	25	50
ELXLDLO602X	Department Level Optional Courses II*Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**125**	**750**

Course Code	Department Level Optional Course II
ELXDLO6021	Microwave Engineering
ELXDLO6022	Electronics Product Design
ELXDLO6023	Wireless Communication
ELXDLO6024	Computer Organization and Architecture

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX 601	Embedded Systems& Real Time Operating System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX 601	Embedded Systems& Real Time Operating System	20	20	20	80	03	--	--	--	--	100

Course Objectives

To study concepts involved in embedded hardware and software for systems realisation.

Course Outcomes At the end of the course, the learner will have the ability to

1. Identify and describe various characteristic features and applications of embedded systems.
2. Analyse and identify hardware for embedded systems implementation.
3. Analyse and identify various software issues involved in Embedded systems for real time requirements.
4. Analyse and explain the design life-cycle for embedded system implementation.

Module		Contents	Time
1.		**Introduction to Embedded Systems**	**04**
	1.1	Characteristics and Design metrics of Embedded system.	
	1.2	Real time systems:Need for Real-time systems, Hard-Soft Real-time systems.	
	1.3	Challenges in Embedded system Design: Power, Speed and Code density.	
		Embedded Hardware	**12**
2.	2.1	Embedded cores, Types of memories, Sensors (Optical encoders, Resistive) and Actuators (Solenoid valves, Relay/switch, Opto-couplers)	
	2.2	Power supply considerations in Embedded systems: Low power features-Idle & Power down mode, Sleep mode, Brown-out detection.	
	2.3	Communication Interfaces: Comparative study of serial communication interfaces (RS-232, RS-485), I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. Selection criteria of above interfaces. **(Frame formats of above protocols are not expected)**	
3.		**Embedded Software**	**14**
	3.l	Program Modelling concepts: DFG,FSM,UML	
	3.2	Embedded C-programming concepts (from Embedded system point of view): Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routine, Device drivers.	
	3.3	Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS, Foreground/Background processes, Interrupt latency, Task, Task states, Multi-tasking, Context switching, Task scheduling, Scheduling algorithms-Rate Monotonic Scheduling, Earliest Deadline First (with numericals), Inter-process communication: Semaphore, Mailbox, Message queues, Event timers, Task synchronisation- Shared data, Priority inversion, Deadlock. Memory Management	
	3.4	Introduction to µCOS II RTOS: Study of Kernel structure of µCOS II, µCOS II functions for Initialisation, Task creation, Inter-task communication and Resource management, Memory management	**08**
4.		**System Integration , Testing and Debugging Methodology**	**04**

	4.1	Embedded Product Design Life-Cycle (EDLC)	
	4.2	Hardware-Software Co-design	
	4.3	Testing & Debugging: Boundary-scan/JTAG interface concepts, Black-Box testing, White-Box testing, Hardware emulation, Logic analyser.	
5.		**Case Studies**	**06**
	5.1	Soft Real-time: Automatic Chocolate Vending machine using µCOS II RTOS- Requirements study, Specification study using UML, Hardware architecture, Software architecture	
	5.2	Hard Real-time: Car Cruise-Control using µCOS II RTOS- Requirements study, specification study using UML, Hardware architecture, Software Architecture	

Text books:

1.Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.
2.Jean J. Labrosse,"MicroC / OS-II The Real-Time Kernel", CMP Books, 2011, Edition 2nd.
3. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
4. SriramIyer, Pankaj Gupta,"Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.

Reference Books:

1.DavidSimon,"An Embedded Software Primer", Pearson, 2009.
2.Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
3.AndrewSloss, DomnicSymes, Chris Wright,"ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004
4.FrankVahid, Tony Givargis,"Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
5.Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total of 4 questions.
3. Question No.1 will be compulsory and based on the entire syllabus.

4. Remaining question (Q.2 to Q.6) will be set from all the modules.
5. Weightage of marks, commensurate with the time allocated to the respective module.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 602	Computer Communication and Networks	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 602	Computer Communication and Networks	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX502 Digital Communication

Course Objectives:

The objectives of this course are to:

1. Introduce networking architecture and protocols
2. Understand the various layers and protocols in the TCP/IP model
3. Recognize different addressing schemes, connecting devices and routing protocols
4. Select the required protocol from the application layer protocols

Course Outcomes:

On successful completion of the course the students will be able to:

1.Demonstrate understanding of networking concepts and required protocols
2. Analyze the various layers and protocols of the layered architecture
3. Evaluate different addressing schemes, connecting devices and routing protocols
4.Appreciate the application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	**06**
	1.1	Uses of computer networks. Topologies, LAN, MAN, WAN, Network topologies, **Addressing :** Physical / Logical /Port addressing, Protocols and Standards.	
	1.2	**Protocol Architecture:** Need of layered protocol architecture, Layers details of OSI, , Protocol Layers and Their Service Models	
	1.3	TCP/IP Model: Protocol suite, Comparison of OSI and TCP/IP	
2.		**Physical Layer**	**08**
	2.1	**Transmission Media:** Guided media like Coaxial, fiber, twisted pair, and Wireless media, Transmission Impairments. Interconnecting Devices: Hub, Bridges, Switches, Router, Gateway	
	2.2	**Data communication model :** DTE, DCE, RS-232D Interface , Null Modem , **Multiplexing :** FDM , Synchronous TDM , Statistical TDM, ADSL , xDSL, Cable	

		Modem	
3.		**Data Link Control**	**08**
	3.1	**Data link services:** Framing, Flow control, Error control, ARQ methods, Piggybacking	
	3.2	**High Level Data Link Control (HDLC):** HDLC configurations, Frame formats, Typical frame exchanges.	
	3.3	**Medium Access Control Protocols**: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.		**Network Layer**	**14**
	4.1	**Switching**: Switched Communication networks, Circuit switching Networks, , Circuit switching Concepts, Packet switching Principles: Virtual circuit switching and Datagram switching	
	4.2	**Routing in Packet Switching Networks:** Characteristics, Routing strategies, Link state Routing versus Distance vector Routing. Least-Cost Routing Algorithms: Dijkstra's Algorithm, Bellman Ford Algorithm.	
	4.3	**Internet Protocol:** Principles of Internetworking: Requirements, Connectionless Operation Internet Protocol Operation: IP packet, IP addressing, subnet addressing , IPv4, ICMP, ARP, RARP IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6)	
5.		**Transport Layer & Application Layer**	**08**
	5.1	**Connection –oriented Transport Protocol Mechanisms: Transmission Control Protocol (TCP):** TCP Services, TCP Header format, TCP three way handshake, TCP state transition diagram. **User datagram Protocol (UDP)**	
	5.2	**Congestion:** Effects of congestion, Congestion control methods, Traffic management, Congestion control in Packet switching Networks	
	5.3	**Application layer Protocols** : HTTP, FTP, DNS,SMTP, SSH	
6.		**LANs.** High speed Ethernet	**04**
	6.1	LAN Protocol architecture , LAN topologies, Hub, Bridges, Virtual LANs **Traditional Ethernet and IEEE 802.3 LAN Standard**: Ethernet protocol, Frame structure, Physical layers,	
	6.2	**High Speed Ethernet** : Fast Ethernet, Gigabit Ethernet & 10- Gigabit Ethernet	
		Total	**48**

Recommended Text Books

1. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition.
2. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
3. Alberto Leon Garcia, "Communication Networks" , McGraw Hill Education, Second Edition

Reference books :

1. S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition.
2. J. F. Kurose and K. W. Ross ,"Computer Networking: A Top-Down Approach", Addison Wesley, 5th Edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 603	VLSI Design	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 603	VLSI Design	20	20	20	80	-	--	--	100

Prerequisite Subject:

- ELX302: Electronics Devices and Circuits- I
- ELX304: Digital Circuit Design
- ELX404: Digital System Design

- ELX504: Design with Linear Integrated Circuits

Course Objectives:

1. To study MOS based circuit realization using different design styles
2. To highlight the fundamental issues in data path and system level design

Course Outcomes: After successful completion of the course student will be able to …

1. Demonstrate a clear understanding of choice of technology, scaling, MOS models and system level design issues.
2. Design and analyze MOS based inverters.
3. Design MOS based circuits with different design styles.
4. Design semiconductor memories, adders and multipliers.

Unit No.	Details	Teaching Hours
1	**Technology Trend :** **1.1 Technology Comparison:** Comparison of BJT and MOS technology **1.2 MOSFET Scaling:** Types of scaling, Level 1 and Level 2 MOSFET Models, MOSFET capacitances	06
2	**MOSFET Inverters:** **2.1 Types of MOS inverters:** Active and passive load and their comparison. **2.2 Circuit Analysis of MOS Inverters:** Static Analysis resistive and CMOS inverter: Calculation of all critical voltages and noise margins. Design of symmetric CMOS inverter. Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay **2.3Logic Circuit Design:** Analysis and design of 2-I/P NAND,NOR and complex Boolean function using equivalent CMOS inverter for simultaneous switching.	10
3	**MOS Circuit Design Styles:** **3.1 Design Styles:** Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS, C^2MOS, Dynamic, Domino,NORA and Zipper. **3.2Circuit Realization:** Basic gates,SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX using above design styles.	10
4	**Semiconductor Memories:** **4.1 SRAM:** 6T SRAM, operation, design strategy, leakage currents, read/write circuits, sense amplifier. **4.2DRAM**: 1T_DRAM, operation modes, leakage currents, refresh operation, physical design. 4.3 **ROM Array**: NAND and NOR PROM, Nonvolatile read/write memories-classification and programming techniques	08
5	**Data Path Design:** **5.1 Adder:** CLA adder, MODL, Manchester carry chainand high speed adders like carryskip, carry select and carry save. **5.2 Multipliers and shifter:** Array multiplier and barrel shifter	04
6	**VLSI Clocking and System Design:** **6.1Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution **6.2Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling **6.3I/O pads and Power Distribution:** ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme	10

	6.4Interconnect: Interconnect delay model, interconnect scaling and crosstalk.	

Text and Reference Books
1.Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition. 2. John P. Uyemura, "Introduction to VLSI CIRCUITS AND SYSTEMS",Wiley India Pvt. Ltd. 3. Jan M. Rabaey, Anantha Chandrakasan and BorivojeNikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition. 4. Etienne Sicard and Sonia Delmas Bendhia, "*Basics of CMOS Cell Design*", Tata McGraw Hill, First Edition. 5. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition. 6. Debaprasad Das, "*VLSI Design*", Oxford, 1st Edition. 7. Kaushik Roy and Sharat C. Prasad, "*Low-Power CMOS VLSI Circuit Design*", Wiley, Student Edition. 8. David A Hodges, Horace G Jackson and Resve A Saleh, "Analysis and Design of Digital Integrated Cicuits", TMH, 3rd Edition
Additional Study Material & e-Books
1.Douglas A Pucknell, Kamran Eshraghian , "Basic VLSI Design", Prentice Hall of India Private Ltd. 2.Samir Palnitkar, " A Guide to Digital Design and Synthesis", Pearson Education

Subject Code	**Subject Name**	**Teaching Scheme**			**Credits Assigned**			
		Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
ELX604	**Signals and Systems**	**04**	**--**	**#01**	**04**	**--**	**01**	**05**

Subject Code	**Subject Name**	**Examination Scheme**							
		Theory Marks				**Term Work**	**Practical**	**Oral**	**Total**
		Internal assessment			**End Sem. Exam**				
		Test 1	**Test 2**	**Ave. Of Test 1 and Test 2**					
ELX604	**Signals and Systems**	**20**	**20**	**20**	**80**	**25**	**-**	**-**	**125**

#Class wise

Course Objectives:

1. To provide a comprehensive coverage of continuous time and discrete time Signals and Systems.
2. To introduce various time domain and frequency domain methods for analysis of Signals and systems.

Course Outcomes:

After successful completion of this course student will be able to

1. Differentiate between continuous time and discrete time Signals and Systems.
2. Understand various transforms for time domain to frequency domain conversion
3. Apply frequency domain techniques for analysis of LTI systems
4. Apply frequency domain techniques for analysis of continuous and discrete signals

Module No.	Unit No.	Topics	Hrs.
1.		**Continuous and Discrete Time Signals**	**8**
	1.1	Mathematical Representation and Classification of CT and DT signals, Orthogonality of signals	
	1.2	Arithmetic operations on the signals, Time Shifting, Time scaling, Time Reversal of signals	
	1.3	Sampling and Reconstruction, Aliasing effect	
2		**Continuous and Discrete Systems**	**8**
	2.1	Mathematical Representation and classification of CT and DT systems	
	2.2	Properties of LTI systems, impulse and step response.	
	2.3	Use of convolution integral, convolution sum and correlation for analysis of LTI systems	
	2.4	Properties of convolution integral and convolution sum	
3		**Frequency Domain Analysis of Continuous Time System using Laplace Transform**	**6**
	3.1	Concept of Complex frequency, Region of Convergence for Causal, Non-causal and Anti-causal systems, Poles and Zero of transfer function	
	3.2	Unilateral Laplace Transform	
	3.3	Analysis and characterization of LTI system using Laplace Transform: Impulse and Step Response, Causality, Stability, Stability of Causal system	
4		**Frequency Domain Analysis of Discrete Time System using Z Transform**	**12**
	4.1	Need for Z transform, definition, properties of unilateral and bilateral Z Transform, mapping with s plane, relationship with Laplace transform	
	4.2	Z transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform	
	4.3	Analysis and characterization of LTI system using Z transform: impulse and step response, causality, stability, stability of causal system	
	4.4	System realization-Direct, Direct Canonic, Cascade and Parallel forms	
5		**Frequency Domainc Analysis of Continuous Signals**	6
	5.1	Frequency Domain Analysis of periodic non-sinusoidal signals	
	5.2	Frequency Domain Analysis of aperiodic Signals-Introduction, Properties of Fourier Transform, Fourier Transform based amplitude and phase response of standard signals, Relationship with Laplace and Z transform, Energy Spectral	
6		**Frequency Domain Analysis of Discrete Signals**	8
	6.1	Discrete Time Fourier Series, Evaluation of DTFS coefficients, Magnitude and Phase Spectrum of Discrete time periodic signals, Power Spectral Density	
	6.2	Discrete Time Fourier Transform – Concept of discrete time signal in frequency domain, definition of DTFT, determination of magnitude and phase functions using DTFT	
		Total	**48**

Text Books:

1. Tarun Kumar Rawat, "*Signals and Systems*", Oxford University*Press 2016.*
2. A. NagoorKani, *"Signals and Systems"*, Tata McGraw-Hill Education

Reference Books:

1. John Proakis and DimitrisMonolakis, "*Digital Signal Processing*", Pearson Publication, 4th Edition
2. Alan V. Oppenheim, AlanS. Willsky, and S.Hamid Nawab, "*Signals and Systems*", 2nd Edition, PHIlearning,2010.
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press,

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO6021	Microwave Engineering	04	--	#01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX6021	Microwave Engineering	20	20	20	80	25	-	-	125

Prerequisites: Knowledge of basic Engineering Electromagnetics

Course Objectives:

1. To introduce the students to various concepts of Microwave Engineering.
2. To teach the students the working principles and applications of different microwave devices.

Course Outcomes (CO):

After successful completion of the course, students will be able to:

1. Understand the importance and applications of microwaves.
2. Explain the process of generation and amplification of microwaves.
3. Analyse the electromagnetic field distribution in various microwave components.
4. Measure various microwave parameters.

Module	Contents	Hours
1	**Introduction to microwave communication** 1.1 Microwave spectrum and bands 1.2 Limitations of conventional circuit theory concepts at microwave frequencies 1.3 Applications of microwaves 1.4 Limitations of conventional vacuum tubes at microwave frequencies	4
2	**Generation and amplification of microwaves** 2.1 **Two cavity Klystron amplifiers:** Construction , Process of velocity modulation and bunching , Apple gate diagram Output power and efficiency , Applications 2.2 **Reflex Klystron:** Construction ,Process of velocity modulation and bunching	12

	Apple gate diagram , Output power and efficiency Applications 2.3 **Cylindrical Magnetron** Construction and working principle Hull cut-off magnetic equation , Cyclotron angular frequency Applications 2.4 **Traveling wave tube**: construction and working principle applications 2.5 numerical examples based on the above topics	
3	**Waveguides:** 3.1 Rectangular and circular waveguides 3.2 solution of Maxwell's equation for distribution of fields in the waveguides 3.3 characteristic equation 3.4 Dominant and degenerate modes 3.5 group and phase velocities 3.6 cut-off frequency 3.7 numerical examples based on the above topics	10
4	**Waveguide components and analysis**: 4.1 Definition and significance of s-parameters 4.2 Properties of s-parameters 4.3 Construction, working principle and s-matrix representation of cavity resonators, waveguide attenuators, waveguide phase shifters, waveguide multiport junctions, E-plane and H-plane Tees, Magic Tee, Hybrid Ring, direction couplers 4.4 Microwave ferrite components: Faraday rotation isolator, Circulator, Gyrator Numerical examples based on the above topics	12
5	Microwave solid state devices: 5.1Principle of operation and characteristics of: Gunn Diode, TRAPATT and IMPATT diodes, Microwave Transistors 5.2 Introduction to Strip Lines	5
6	Microwave Measurement: Measurement of 6.1 Power 6.2 Attenuation 6.3 Frequency 6.4 VSWR 6.5 Cavity Q 6.6 Impedance	5

Text Books:

1. " Microwave Devices and Circuits" by Samuel Liao, PHI
2. "Microwave circuits and Passive Devices" by M L Sisodia, G S Raghuvanshi, New Age International(P) Ltd

Reference Books:

1. " Electronic Communication Systems" by Kennedy, Davis, 4e TMH
2. " Microwave Engineering: Passive Circuits" by Peter Rizzi, PHI
3. " Foundations for Microwave Engineering" by Robert E Collin, 2e, John Wiley
4. " Basic Microwave Techniques & Laboratory Manual" by M L Sisodia, G S Raghuvanshi, 2001 New Age International(P) Ltd
5. Microwave Engineering, Annapurna Das, TMH\

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6022	Electronic Product Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX DLO6022	Electronic Product Design (EPD)	20	20	20	80	---	---	100

Rationale :- The aim of this course is to enable students to gain practical experience & nurture their creativity in electronic product design & the objective is to provide students with a clear understanding of the practical design problems of the electronic products at an introductory level. With this course, students are expected to become familiar with the concept of designing a product as per the requirements (non-technical) & given specifications (technical), component tolerances, production constraints, safety requirements & EMC standards.

Course Objectives:-

1. To understand the stages of product (hardware / software) design & development
2. To learn different considerations of analog, digital & mixed circuit design
3. To be acquainted with methods of PCB design & different tools used for the same
4. To be aware of the importance of testing in product design cycle
5. To gain knowledge about various processes & importance of documentation

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Design electronic products using user-centered designing processes
- **CO-2 :-** Identify & recognize essential design & production procedures of electronic products
- **CO-3 :-** Implement a prototype for meeting a particular requirement / specification
- **CO-4 :-** Demonstrate problem solving & troubleshooting skills in electronic product design
- **CO-5 :-** Prepare the relevant set of design documentation & present it as a case study

Module No.	Topics	Hours
1	**INTRODUCTION TO ELECTRONIC PRODUCT DESIGN** Man-machine dialog & industrial design, user-centered design, elements of successful design, cognition, ergonomics, packaging & factors; design for manufacture, assembly & disassembly wiring, temperature, vibration & shock; safety, noise, energy coupling, grounding, earthing, filtering & shielding	**06**
2	**HARDWARE DESIGN & TESTING METHODS** Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design, functional model v/s architectural model, prototyping, performance & efficiency measures, formulating a test plan, writing all the specifications, test procedures & test cases, design reviews, module debug & testing – black box testing, white box testing, grey box testing	**10**
3	**SOFTWARE DESIGN & TESTING METHODS** Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention, software bugs & testing, good programming practice, user interface, embedded & real-time software	**10**
4	**PRINTED CIRCUIT BOARD (PCB) DESIGNING** Fundamental definitions, standards, routing topology configuration, layer stack up assignment, grounding methodologies, aspect ratio, image planes, functional partitioning, critical frequency & bypassing, decoupling; design techniques for ESD protection, guard-band & guard-rings	**08**
5	**PRODUCT DEBUGGING & TESTING** Steps of debugging, the techniques for troubleshooting, characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components, inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	**08**
6	**THE DOCUMENTATION PROCESS** Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents, methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual, fault finding tree, software documentation practices	**06**
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
2. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
3. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press
4. G. C. Loveday, Electronic Testing & Fault Diagnosis, 4th edition, A. H. Wheeler Publishing
5. James K. Peckol, Embedded Systems – A Contemporary Design Tool, 1st edition, Wiley Publication
6. J. C. Whitaker, The Electronics Handbook, CRC Press

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX DLO6023	Wireless Communication	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX DLO6023	Wireless Communication	20	20	20	80	-	--	--	100

Course Objectives:

The objectives of this course are to:

1. To introduce the Concepts of basic Cellular communication systems , mobile Radio propagation
2. To understand the various Cellular processes such as handoff strategies, interference, Trunking theory
3. To study the features and services of 2G cellular technologies: GSM and CDMA
4. To study the features of evolving technological advances in 2G, 3G & 4G Cellular systems.

Course Outcomes:

After successful completion of the course, students will be able to:

1.Understand the concepts of basic cellular system, frequency reuse, channel assignment
2. Understand the fundamentals radio propagation , Path loss and comprehend the effect of Fading .
3. Acquire the Knowledge about multiple access technologies and different of different spread spectrum techniques.
4. Acquire the Knowledge about overall GSM cellular concept and analyse its services and features
5. Comprehend the features of CDMA technology
6. Analyse the evolution of cellular technology from 2G to 4G Cellular systems .

Module No.	Unit No.	Topics	Hrs.
1.		**Concept of Cellular Communication**	**08**
	1.1	Introduction to cellular communications, Frequency reuse, Channel assignment strategies	
	1.2	**Cellular Processes:** Call setup, Handoff strategies, interference and system capacity, Co-channel Interference reduction with the use of Directional Antenna	
	1.3	**Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity in Cellular systems: Cell splitting, Sectoring, Micro-cell Zone concept	
2.		**Mobile Radio Propagation**	**08**

	2.1	Introduction to Radio wave propagation, Free space propagation model, the three basic Propagation mechanisms, The Ground Reflection (two-ray) model, Practical Link budget design using Path-Loss models:Log-distance Path –loss model.	
	2.2	Small scale Multipath Propagation: Factors influencing small scale fading, Doppler shift, Parameters of mobile multipath channels,	
	2.3	Types of small scale fading, Fading effects due to Doppler spread, Fading effects due to Multipath Time delay spread, Raleigh and Rician distributions	
3.0		Multiple access techniques & Spread spectrum Modulation	**08**
	3.1	Multiplexing and Multiple Access:Time Division Multiple Access, Frequency Division Multiple Access, Spread-spectrum multiple-access:Code Division Multiple Access	
	3.2	Spread spectrum Modulation :Need for and concept of spread spectrum modulation, PN-sequence generation, properties of PN-sequence, Gold sequence generation, Direct-sequence SS, Frequency-hopping SS,	
4.0		**GSM**	**12**
	4.1	GSM network architecture, Signalling protocol architecture, Identifiers, Physical and Logical Channels, Frame structure, Speech coding, Authentication and security, Call procedure, Hand-off procedure, Services and features	
5.0		**IS-95**	**06**
	5.1	Frequency and channel specifications of IS-95, Forward and Reverse CDMA channel, Packet and Frame formats, Mobility and Resource management	
6.0		**Evolution from 2G to 4G**	**06**
	6.1	GPRS, EDGE technologies, 2.5G CDMA-One cellular network, W-CDMA (UMTS), CDMA2000, LTE, Introduction to 5G Networks	
		Total	**48**

Recommended Books:

6. Theodore Rappaport, "Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
7. ITI Saha Misra, "Wireless Communication and Networks: 3G and Beyond", Publication
8. Vijay Garg, "IS-95 CDMA and cdma 2000: Cellular/PCS System Implementation", Pearson Publication.

Reference Books:

1. T.L Singal , "Wireless Communication", Tata McGraw Hill ,2010
2. Upena Dalal , "Wireless Communication", Oxford University Press, 2009
3. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
4. Vijay Garg, "Wireless communication and Networking", Pearson Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to marks will be asked.
4: Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELX DLO6024	Computer Organization and Architecture	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELX DLO6024	Computer Organization and Architecture	20	20	20	80	03	--	--	--	--	100

Course Objectives	1. To introduce the learner to the design aspects which can lead to maximized performance of a Computer. 2. To introduce the learner to various concepts related to Parallel Processing 3.To highlight the various architectural enhancements in modern processors.
Course Outcomes	At the end of the course, the learner will have the ability to 1. Define the performance metrics of a Computer 2.Explain the design considerations of Processor, Memory and I/O in Computer systems 3. Explain the advantages and limitations of Parallelism in systems 4. Explain the various architectural enhancements in modern processors

Module		Contents	Time
1.		**Introduction to Computer Organization**	**[06]**
	1.1	Fundamental Units of a Computer	01
	1.2	Introduction to Buses	01
	1.3	Number Representation methods- Integer and Floating-point, Booth's Multiplier, Restoring and Non-Restoring Division	03
	1.4	Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	01
2.		**Processor Organization and Architecture**	**10**
	2.1	CPU Architecture , Register Organization, Instruction cycle, Instruction Formats	04
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	04
	2.3	Comparison between CISC and RISC architectures	02
3.		**Memory Organization**	**12**
	3.l	Classification of Memories-Primary and Secondary Memories, RAM (SRAM and DRAM) and ROM (EPROM , EEPROM), Memory Inter-leaving	02
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency (* Numerical Problems expected)	06
	3.3	Virtual Memory Management-Concept, Segmentation , Paging, Page Replacement policies	04
4.		**Input/Output Organization**	**06**
	4.1	Types of I/O devices and Access methods, Types of Buses , Bus Arbitration	03
	4.2	Expansion Bus Concept, PCI Bus	03
5.		**Parallelism**	**06**
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, Amdahl's law	02
	5.2	Pipelining - Concept, Speedup, Efficiency , Throughput, Types of Pipeline hazards and solutions (* Numerical Problems expected)	04
6.		**Architectural Enhancements**	**08**
		Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, Non-Uniform Memory Access (NUMA) systems, Vector Computation , GPU	08

Text books:

1.William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.

2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill, 2002.

Reference Books:

1. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

2. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.

3. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann,1998.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:
Question paper will comprise of 6 questions, each carrying 20 marks.

The Learner need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 601	Embedded Systems& Real Time Operating System Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg							
ELXL 601	Embedded Systems& Real Time Operating System Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 601 (Embedded System & Real Time Operating System)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

- Simulation experiments using KeilC–cross complier to: evaluate basic C program for X-51 assembly; evaluating various C data types; evaluating and understanding iterative C constructs translated into x51's assembly; evaluating and understanding interrupt implementation.
- Simulate and understand working of μCOS-II functions using example programs from recommended text,"MicroC / OS-II The Real-Time Kernel", by Jean J. Labrosse.
- Porting of μCOS-II on X-51/AVR/CORTEX M3 platform.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 602	Computer Communication and Networks Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 602	Computer Communication and Networks Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes Seven experiments and a Case study(Power point Presentation) on any one of the suggested topics.

1. The experiments will be based on the syllabus contents.

2. Minimum **Seven experiments** need to be conducted, out of which **at least Four Experiments** should be software-based (C/C++ , Scilab, MATLAB, LabVIEW, etc).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work. The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology. ("Beyond the scope of the syllabus".)

Power point presentation should contain minimum of 15 slides and students should submit a report (PPT+Report)carry minimum of 10 marks . The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of experiments:

1. Study of transmission media and interconnecting devices of communication networks.
2. Implementation of serial transmission using RS232
3. Implementing bit stuffing algorithm of HDLC using C/C++
4. Implementation of Routing protocols using C/C++
5. Study of NS2 simulation software
6. Implementation of TCP/UDP session using NS2
7. Implementation of ARQ methods using NS2
8. Study of WIRESHARK and analyzing Packet using WIRESHARK
9. Study and implementation of IP commands
10. Study of GNS software and implementation of routing protocols using GNS

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL 603	VLSI Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL 603	VLSI Design Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELX 603 (VLSI Design)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Suggested Experiments:

MOSFET Scaling using circuit simulation software like Ngspice

Static and transient performance analysis of various inverter circuits

Implementation of NAND and NOR gate using various logic design styles

Design and verification of CMOS Inverter for given static and transient performance

Implementation of ROM, SRAM, DRAM

Interconnect analysis

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6021	Microwave Engineering Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
ELXL DLO6021	Microwave Engineering Laboratory	--	--	--	--	--	25	--	--	25	50

Assessment:

Term Work:

At least **SIX** experiments based on the entire syllabus of **ELXDLO 6021 (Microwave Engineering)** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are also encouraged. The experiments should be students' centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time. Term work must include a mini project in addition to the number of experiments. The course mini-project is to be undertaken in a group of two to three students.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work, mini project and minimum passing marks in term work.

Practical and Oral exam will be based on the entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ELXL DLO6022	Electronic Product Design	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg							
ELXL DLO6022	Electronic Product Design	--	--	--	--	--	25	--	--	25	50

At least **Six** experiments based on the entire syllabus of **ELXDLO6022 (**Electronic Product Design**)** should be set to have well-defined inference and conclusion. The experiments should be student-centric and attempt should be made to make experiments more meaningful, interesting and innovative. Experiment must be graded from time to time. Additionally, each student (in group of 2/3) has to perform a Mini Project as a part of the laboratory and report of mini project should present in laboratory journal. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Lab session includes **six experiments plus one presentation on case study.**

Suggested Experiments:

1. Experiment based on Ground and Supply bounce
2. PCB design steps involved in product design
3. Simulation based on use of Simulator software
4. Working of an Emulator in Design step
5. Role of Pattern Generator in Design step
6. Debugging of the digital circuit based on Logic Analyzer
7. Application of the Spectrum analyzer
8. Demonstration of usefulness of the Arbitrary waveform generator
9. Setup for EMI and EMC test
10. Experiment based on calibration of the product.

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL DLO6023	Wireless Communication Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL DLO6023	Wireless Communication Laboratory	-	-	-	-	25	--	25	50

Laboratory Experiments:

Lab session includes seven experiments and a Case study(Power point Presentation)on any one of the suggested topics.

Note:

1. The experiments will be based on the syllabus contents.

2. Minimum seven experiments need to be conducted.(Scilab, MATLAB, LabVIEW, NS2/NS3 etc can be used for simulation).

3. Each student (in groups of 3/4) has to present a Case study (Power point Presentation) as a part of the laboratory work.

The topics for Presentation / Case-study may be chosen to be any relevant topic on emerging technology.

("Beyond the scope of the syllabus".)

Power point presentation should contain minimum of 15 slides and students should submit a report , (PPT+Report) carry minimum of 10 marks The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai Students should be motivated to publish a paper in Conferences/students competitions based on the work

AC19.04.2017
Item No. X.XX

UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Subject	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Lab.						25	25	50
ELXL702	Power Electronics Lab.						25	25	50
ELXL703	Digital signal processing Lab.						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703X	Dept. Level Optional courses III Lab.						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[#]
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

B.E. (Electronics Engineering)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04	--	---	04	---	---	04
ELX702	Power Electronics	04	--	---	04	---	---	04
ELX703	Digital signal processing	04	--	---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04	--	---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03	---	---	03	---	---	03
ELXL701	Instrumentation System Design Lab.		02			01	---	01
ELXL702	Power Electronics Lab.		02			01	---	01
ELXL703	Digital signal processing Lab.		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Dept. Level Optional course III Lab.		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELX801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	---	**24**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 701	Instrumentation System Design	04	---	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELX 701	Instrumentation System Design (ISD)	20	20	20	80	---	---	100

Rationale :- For optimum operation & satisfactory performance of any industrial process control system, it is necessary to have a reliably engineered system with a thorough knowledge of the process conditions & requirements as per the system or design specifications. This subject introduces various nuances in the design of instrumentation systems, which is itself a synergy of sensors, transducers, actuators, process control & electronic systems to achieve the desired operation of a plant or the proper control of an industrial process. Students are exposed to principles of designing which enable them to design, build & implement such electronically controlled systems for measurement, signal conditioning & final control.

Course Objectives :-

1. To learn basic functions & working of pneumatic, hydraulic & electrical components used in process control
2. To understand principles of process parameter conversion & transmission in various forms
3. To gain familiarity with control system components & their applications in process control
4. To study various types of controllers used in process control & their tuning for different applications
5. To be aware of recent advances & technological developments in industrial instrumentation & process control

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **ELX 701.1 :-** Demonstrate the needs of advancement in instrumentation systems
- **ELX 701.2 :-** Select the proper components for pneumatic & hydraulic systems
- **ELX 701.3 :-** Choose the transmitter / controller for given process application
- **ELX 701.4 :-** Analyze the controller parameters for discrete or continuous type
- **ELX 701.5 :-** Design the controller (electronic) for a given process or application

Module No.	Topics	Hours
1	**ACTUATORS & PROCESS CONTROL VALVES**	**08**
1.1	Electrical actuators – relays, solenoids & electrical motors (DC, AC & stepper motor)	
1.2	Pneumatic actuators – basic pneumatic system, pneumatic compressors (piston, vane, screw) flapper nozzle, single & double acting cylinder, rotary actuator, filter-regulator-lubricator (FRL)	
1.3	Hydraulic actuator – hydraulic pumps, control valves types (globe, ball, needle, butterfly, gate, diaphragm & pinch), cavitation & flashing with their remedies, pressure drop across valve & leakage, valve noise, flow characteristics on load changes, control valves parameters, control valves sizing, valve calibration, digital control valves, selecting control valves & applications	
2	**DESIGN OF SIGNAL CONDITIONING CIRCUITS**	**08**
2.1	Principles of analog & digital signal conditioning – signal level & bias change, linearization, conversion, filtering & impedance matching, concept of loading, comparators & converters	
2.2	Design of operational amplifier based circuits in instrumentation – analysis of voltage divider circuits, bridge circuits, RC filters, inverting & non-inverting amplifier, instrumentation amplifier, V to I & I to V converter, integrator, differentiator & linearization (with numerical examples)	
2.3	Transmitters – Introduction to telemetry & its basic block diagram, 2 wire, 3 wire & 4 wire transmitters, 4 mA to 20 mA current transmitter, electronic transmitters for temperature, level, pressure & flow, current to pressure (I to P) & pressure to current (P to I) converters	
3	**PROCESS CONTROLLER PRINCIPLES**	**08**
3.1	Discontinuous controller – two position mode, multi-position mode & floating mode	
3.2	Continuous controller – single mode (P, I & D) & composite mode (PD, PI & PID), split range, auto select, ratio & cascaded controllers, selection criterion of controller for a process mode	
3.3	Tuning of PID controller – process loop tuning, open loop transient response method, Ziegler – Nichols tuning method, frequency response methods (numerical examples on PID tuning)	
4	**PROGRAMMABLE LOGIC CONTROLLERS (PLC)**	**10**
4.1	Discrete state process controller – discrete state variables, process specifications & event sequence description	
4.2	Relay controller & ladder diagram – introduction to relay ladder diagram logic, ladder diagram elements & ladder diagram programming examples	

4.3	PLC – relay sequencers, programmable logic controller design, PLC operation, programming the PLC, PLC software functions (application examples on relay ladder logic programming)	
5	**DIGITAL BASED PROCESS CONTROL**	**08**
5.1	Data acquisition system (DAS) – objectives, signal conditioning of inputs, single channel DAS, multi-channel DAS, computer based DAS, data logger, difference between DAS & data logger	
5.2	Computer aided process control – architecture, human machine interface (HMI), supervisory control & data acquisition (SCADA), standard interfaces (RS-232C, RS-422A & RS-485)	
5.3	Supervisory control system (SCS), introduction to the Fieldbus & Profibus process controlled networks, overview of distributed control system (DCS), features & advantages of DCS	
6	**CALIBRATION STANDARDS & ADVANCES IN INSTRUMENTATION**	**06**
6.1	PC & microcomputer based instrumentation, virtual instrumentation & LabVIEW introduction	
6.2	Calibration of instrumentation systems, representation of instrumentation control process with SAMA & ISA symbols, ISO/IEC 17025 General requirements for calibration standards	
6.3	Instrumentation standards, ISA S82.01 – Safety Standard for Electrical and Electronic Test, Measuring, Controlling Related Equipment, ISA S84.01 – Application of Safety Instrumented Systems for the Process Industries, ANSI/NEMA 250 – Enclosures for Electrical Equipment	
1 – 6	**TOTAL**	**48**

Recommended Books :-

1. Curtis D. Johnson, Process Control Instrumentation Technology, 7th edition, PHI
2. S. K. Singh, Industrial Instrumentation & Control, 3rd edition, McGraw Hill
3. B.C. Nakra & K. K. Chaudhary, Instrumentation Measurement & Analysis, 3rd edition, McGraw Hill
4. Andrew Parr, Pneumatics & Hydraulics, 2nd edition, Jaico Publishing Co.
5. B. G. Liptak, Handbook of Process Control & Instrumentation, 4th edition, CRC Press
6. William C. Dunn, Fundamentals of Industrial Instrumentation & Process Control, 1st edition, McGraw Hill

Internal Assessment (IA) :-Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Q.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX702	Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	ExaminationScheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX702	Power Electronics	20	20	20	80	03	--	--	--	100

\Course Pre-requisite:

1. ENAS
2. EDC-1
3. EDC-2

Course Objectives:

1. To teach power electronic devices and their characteristics.
2. To highlight power electronics based rectifiers, inverters and choppers.

Course Outcomes:

After successful completion of the course students will be able to:

1. Discuss trade-offs involved in power semiconductor devices.
2. Design of triggering, commutation and protection circuits for SCRs.
3. Analyse different types of single-phase rectifiers and DC-DC converters.
4. Analyse different types of DC-AC converters (inverters).
5. Analyse different types of AC Voltage Controllers and Cycloconvertors.

Module No.	Unit No.	Contents	Hrs.
1		**Power semiconductor devices**	8
	1.1	Principle of operation of SCR, static and dynamic characteristics, gate Characteristics,	
	1.2	Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC, MOSFET and power BJT. IGBT: basic structure, principle of operation, equivalent circuit, latch-up in IGBT's and V-I characteristics.	
2		**SCR: Triggering, commutation and Protection Circuits**	8
	2.1	Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine),	
	2.2	Design of commutation circuits,	
	2.3	Protection of SCR	
3		**Single-phase Controlled Rectifiers**	8
	3.1	Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	
	3.2	Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.	
	3.3	Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HF/THD), Crest Factor (CF)), output performance parameters.	
4		**Inverters**	10
	4.1	Introduction to basic and improved series/parallel inverters, limitations.	
	4.2	Introduction, principle of operation, performance parameters of Single phase half / full bridge voltage source inverters with R and R-L load,	
	4.3	Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications	
5		**DC-DC converters**	8
	5.1	Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators (CCM mode only)	
	5.2	Voltage commutated, current commutated and load commutated DC-DC	

		converters	
	5.3	Applications in SMPS, Battery charging systems.	
6		**AC Voltage Controllers and Cycloconvertors**	**6**
	6.1	Principle of On-Off control, principle of phase control, single phase bidirectional control with R and RL load	
	6.2	Introduction, single phase and three phase Cyclo-converters, applications	
		Total	**48**

Recommended Books:

1. M. H. Rashid, "*Power Electronics*", Prentice-Hall of India
2. Ned Mohan, "*Power Electronics*", Undeland, Robbins, John Wiley Publication
3. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012
4. M.D. Singh and K. B. Khanchandani, "*Power Electronics*", Tata McGraw Hill
5. Ramamurthy, " *Thyristors and Their Applications*"
6. P. C. Sen, "*Modern Power Electronics*", Wheeler Publication
7. S. Shrivastava, "Power Electronics", Nandu Publication, Mumbai.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 and Test 2					
EXC703	Digital Signal Processing	20	20	20	80	--	--	--	100

Prerequisite Courses: Signals and Systems

Course Objectives:

1. To teach the design techniques and performance analysis techniques of digital filters
2. To introduce the students to advanced signal processing techniques, digital signal processors and applications

Course Outcomes:

After successful completion of this course students will be able to

1. Demonstrate an understanding of the discrete-time Fourier transform and the concept of digital frequency.
2. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
3. Understand the effect of hardware limitations on performance of digital filters
4. Use advanced signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform and Fast Fourier Transform**	10
	1.1	Definition and Properties of DFT,IDFT, circular convolution of sequences using DFT and IDFT, Relation between Z-transform and DFT Filtering of long data sequences: Overlap Save and Overlap Add Method Computation of DFT	
	1.2	Fast Fourier transforms(FFT),Radix-2decimationintime and decimation in frequency FFT algorithms, inverse FFT, and Introduction to composite FFT	
2.0		**IIR Digital Filters**	10
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band stop and All Pass) Analog filter approximations: Butterworth, Chebyshev I and II	
	2.2	MappingofS-planetoZ-plane,impulseinvariancemethod,bilineartransformation method, Design of IIR digital filters from analog filters with examples	
	2.3	Analog and digital frequency transformations with design examples	
3.0		**FIR Digital Filters**	10
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zero sof linear phase FIR filters	

	3.2	Design of FIR filter susing window techniques (Rectangular, Hamming, Hanning,Blackmann, Barlet) Design of FIR filter susing Frequency Sampling technique Comparison of IIR and FIR filters	
4.0		**Finite Word Length Effects in Digital Filters**	**06**
	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling	
	4.2	Quantization in Floating Point realization of IIR digital filtersFinite word length effects in FIR digital filters	
5.0		**Multirate DSPand FilterBanks**	**06**
	5.1	Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer numbers Multistage Approach to Sampling rate converters	
	5.2	Sample rate conversion using Polyphase filter structure, Type I and Type II Polyphase Decomposition	
6.0		**DSP Processors and Applications**	**06**
	6.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator(MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism	
	6.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware	
	6.3	Applications of DSP: Radar Signal Processing and Speech Processing	
Total			**48**

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing"*, A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, " *Digital Signal Processing"*, Oxford University Press, 2015

Reference Books:

1. ProakisJ., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
2. Sanjit K. Mitra , Digital Signal Processing – A Computer Based Approach – edition 4e
3. McGraw Hill Education (India) Private Limited
4. OppenheimA.,SchaferR.,BuckJ.,"*DiscreteTimeSignalProcessing*",2ndEdition, Pearson Education..
5. B. VenkataRamaniand, M. Bhaskar, "*Digital Signal Processors, Architecture, Programming andApplications*", Tata McGraw Hill, 2004.
6. L.R.RabinerandB.Gold,"*TheoryandApplicationsofDigitalSignalProcessi*ng",Prentice-HallofIndia, 2006.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5markswill be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7031	NEURAL NETWORKS & FUZZY LOGIC	20	20	20	80	-	--	--	100

Pre-requisite

- Knowledge of linear algebra, multivariate calculus, and probability theory
- Knowledge of a programming language (MATLAB /C/C ++ recommended)

Course Objectives:

- To study basics of biological Neural Network.
- To understand the different types of Artificial Neural Networks
- To know the applications of ANN .
- To study fuzzy logic and fuzzy systems.

Course outcomes:

At the end of completing the course of Neural Networks & Fuzzy Logic, a student will be able to:

1. Choose between different types of neural networks
2. Design a neural network for a particular application
3. Understand the applications of neural networks
4. Appreciate the need for fuzzy logic and control

Module	Contents	Hours
1	**Introduction:**1.1 Biological neurons, McCulloch and Pitts models *of* neuron, Types of activation function, Network architectures, Knowledge representation, Hebb net 1.2 Learning processes: Supervised learning, Unsupervised learning and Reinforcement learning 1.3 Learning Rules : Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner-Take-All Learning Rule 1.4 Applications and scope of Neural Networks	**10**
2	**Supervised Learning Networks :** 2.1 Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent, – least mean square algorithm, Linear & non-linear separable classes & Pattern classes, 2.2 Back Propagation Network, 2.3 Radial Basis Function Network.	**12**
3	**Unsupervised learning network:** 3.1 Fixed weights competitive nets, 3.2 Kohonen Self-organizing Feature Maps, Learning Vector Quantization, 3.3 Adaptive Resonance Theory – 1	**06**
4	**Associative memory networks:** 4.1 Introduction, Training algorithms for Pattern Association, 4.2 Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, 4.3 Discrete Hopfield Networks.	**08**
5	Fuzzy Logic: 5.1 Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence 5.2 Fuzzification and Defuzzification 5.3 Fuzzy Controllers	**12**

TOTAL	**48**

Text- Books:

- Dr. S. N. Sivanandam, Mrs S.N. Deepa, *"Principles of Soft computing"*, Wiley Publication.
- Jacek M. Zurada, *"Introduction to Artificial Neural Systems,* Jaico publishing house.

Reference books :

- Simon Haykin, "*Neural Network* a - *Comprehensive Foundation",* Pearson Education.
- S. Rajsekaran, Vijaylakshmi Pai, *"Neural Networks, Fuzzy Logic, and Genetic Algorithms"*, PHI.
- Thimothy J. Ross, "*Fuzzy Logic with Engineering Applications",* Wiley Publication.
- Christopher M Bishop, *"Neural Networks For Pattern Recognition"* ,Oxford Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of total 6 questions, each of 20 marks.
2. Only 4 questions need to be solved.
3. Question number 1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.
5. No question should be asked from pre-requisite module

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7032	Advanced Networking Technologies	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7032	Advanced Networking Technologies	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX405 Principles of Communication Engineering
ELX602 Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:
The objectives of this course are to:

1. Understand the characteristic features of Various Wireless networks
2. Understand Optical networking and significance of DWDM.
3. Introduce the need for network security and safeguards
4. Understand the principles of network management

Course Outcomes:

On successful completion of the course the students will be able to:

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM)
3. Understand the features of emerging wireless Networks: Bluetooth Networks,ZIGBEE, WSN
4. Analyze the importance of Optical networking
5. Demonstrate knowledge of network design and security and management
6. Understand the concept of Cloud Computing and its applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Wireless LAN and WAN technologies**	**08**
	1.1	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations .	
	1.2	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM	

		cells , ATM Functional Layers, Congestion control and Quality of service	
2.		**Emerging Wireless Technologies**	**10**
	2.1	**Wireless Personnel Area Network(WPAN):** WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	2.2	802.15.3- Ultra Wide Band , 802.15.4- Zigbee , RFID	
	2.3	**Wireless Sensor Networks: Introduction and Applications,** Wireless Sensor Network Model, Sensor Network Protocol Stack,	
3.0		**Optical Networking**	**08**
	3.1	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	3.2	DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations	
4.0		**Network Design, Security and Management**	**10**
	4.1	3 tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	
	4.2	Network Security: Security goal, Security threats, security safeguards, firewall types and design.	
	4.3	Network management definitions, functional areas (FCAPS), SNMP,RMON	
5.0		**Routing in the Internet:**	**06**
	5.1	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	5.2	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
6.0		**Cloud computing:**	**06**
	6.1	Cloud Computing Evolution, Definition, SPI framework of Cloud Computing, Cloud service delivery models,	
	6.2	Cloud deployment models, key drivers to adoption of cloud, impact of cloud computing on users, examples of cloud service providers: Amazon, Google, Microsoft, Salesforce etc.	
		Total	**48**

Recommended Text Books:

1. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
2. Darren L. Spohn , “Data Network Design” , McGraw Hill Education ,Third edition
3. William Stallings, “Data and Computer communications”, Pearson Education, 10th Edition.
4. Tim Mather , Subra Kumaraswamy & Shahed Latif, “Cloud security & Privacy: an enterprise Perspective”, O’Reilly Media Inc.Publishers

Reference Books:

1. William Stallings, “Wireless Communications and Networks”, Pearson Ed., 2nd Edition.

2. Vijay Garg ,"Wireless Communication and networking" , Morgan Kaufmann Publishers
3. Carr and Snyder, " Data communication and network security" , McGraw Hill ,1ST edition.
4. Upena Dalal & Manoj Shukla , " Wireless Communication and Networks", Oxford Press
5. Deven Shah , Ambavade, "Advanced Communication Networking"
6. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7033	Robotics	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO7033	Robotics	20	20	20	80	-	--	--	100

Pre-requisite: Applied Mathematics III, Applied Mathematics IV ,Linear Control Systems

Course Objectives:

1. To study basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3 To familiarize students with Trajectory & task planning of robots.
4 To familiarize students with robot vision

Course outcomes:

At the end of completing the course of Robotics, a student will be able to:

1. understand the basic concepts of robotics
2. perform the kinematic and the dynamic analysis of robots
3. perform trajectory and task planning of robots
4. describe importance of visionary system in robotic manipulation

Module	Contents	Hours
1	**Fundamentals of Robotics:** 1.1 Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	**04**
2	**Kinematics of Robots:** 2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation 2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	**10**
3	**Velocity Kinematics & Dynamics:** 3.1 **Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities, 3.2 **Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot	**10**
4	**Trajectory planning:** 4.1 Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	**08**
5	**Robot Vision:** 5.1 Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration	**08**
6	**Task Planning:** 6.1 Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	**08**
	TOTAL	**48**

Text- Books :

- Robert Shilling, “Fundamentals of Robotics - Analysis and contro”l, Prentice Hall of India, 2009
- Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011

Reference books :

- John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
- Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
- Mikell P. Groover et.al, ”Industrial Robots-Technology, Programming & applications”, McGraw Hill , New York, 2008

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO7034	IC Technology	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ELXDLO7034	IC Technology	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ELX302:Electronic Devices and Circuits I
- ELX303:Digital Circuit Design
- ELX603:VLSI Design

Course Objectives:

1. To provide knowledge of IC fabrication processes and advanced IC technologies.
2. To disseminate knowledge about novel VLSI devices and materials.

Course Outcomes:

After successful completion of the course student will be able to

1. Demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Crystal Growth, Wafer preparation and fabrication for VLSI Technology**	8
	1.1	**Semiconductor Manufacturing:** Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering.	
	1.2	**Semiconductor Substrate:** Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	12
	2.1	**Epitaxy:** Classification**,** Molecular Beam Epitaxy	
	2.2	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of	
		Silicon Dioxide, Oxide Quality.	
	2.3	**Device Isolation:** LOCOS, Shallow Trench Isolation (STI).	
	2.4	**Deposition: Physical Vapor Deposition-**Evaporation and Sputtering, **Chemical Vapor Deposition:** APCVD, LPCVD,PECVD	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion.	
	2.5	**Ion Implantation:** Penetration range-Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	
3.0		**Fabrication Process Part 2**	12
	3.1	**Etching &Lithography:** **Etching:** Basic concepts and Classification **Lithography:** Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography	
	3.2	**Metallization and Contacts:** Introduction to Metallization, Schottky contacts and Ohmic contacts.	
	3.3	**CMOS Process Flow:** N well, P-well and Twin tub, CMOS Latch Up	
	3.4	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried	

		and Butting Contact	
4.0		**Measurement and Testing**	06
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility,	
	4.2	**Testing:** Technology trends affecting testing, VLSI testing process and test	
		equipment, test economics and product quality	
		VLSI Technologies	05
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD SOI and FD SOI Device structure and their features	
	5.2	**Advanced Technologies:** low κ and high κ, BiCMOS, HκMG Stack, Strained Silicon.	
	5.3	**GaAs Technologies:** MESFET Technology, MMIC technologies, MODFET	
		Novel Devices and Materials	
	6.1	**Multigate Devices*:*** Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). **Nanowire:** Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires.	05
	6.2	**2-D Materials and FET:** Graphene& CNT FET, MOS2 and Black Phosphorous.	
		Total	**48**

Recommended Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.

2. Stephen A. Campbell, "*The Science and Engineering of Microelectronic Fabrication"*, Oxford University Press, 2nd Edition.

3. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "*Fundamentals of Semiconductor Fabrication*", Wiley, First Edition.

5. Kerry Bernstein and N. J. Rohrer, "*SOI Circuit Design Concepts",* Kluwer Academic Publishers, 1st edition.

6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors",* Springer, 1st edition

7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1st edition.

8. James E. Morris and KrzysztolIniewski, "*Nanoelectronic Device ApplicationsHandbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press

10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing fordigital, memory and mixed-signal VLSI circuits*", Springer

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, “Taguchi Technique for Quality Engineering,” McGrawHill
7. Madhav S Phadke, “ Quality Engineering using Robust Design,” Prentice Hall

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem,	14

	Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication

8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL701	Instrumentation System Design Laboratory	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL701	Instrumentation System Design Laboratory	---	---	---	---	25	25	50

Term Work :-

At least 06 experiments covering entire syllabus of ELX 701 (Instrumentation System Design) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments :-

1. Study of pneumatic single acting & double acting cylinder
2. Study of hydraulic process control valves
3. Design of stepper motor interface & controller
4. Design of instrumentation amplifier for variable voltage gain
5. Design of signal conditioning circuits for LDR / thermistor / RTD / strain gauge
6. Design of linearization circuits for transducers
7. Design of temperature P+I+D controller
8. Tuning of P+I+D controller using MATLAB / Simulink
9. Implementation of PLC ladder diagram for given application
10. Study of SCADA & HMI
11. Designing of data acquisition system (DAS)
12. Simulating a simple process using LabVIEW

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL702	Power Electronics	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL702	Power Electronics	---	---	---	---	25	25	50

Term Work :-

At least 06 experiments covering entire syllabus of ELX 702 (Power Electronics) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will

be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of Experiments

1. Characteristics of SCR, DIAC, TRAIC.
2. Characteristics of IGBT, MOSFET and Power BJT.
3. Firing circuit for SCR using UJT.
4. Study of Half wave and Full wave rectifiers using diodes.
5. Study of Half wave and Full wave controlled rectifiers.
6. Buck converter, Boost converter and Buck-Boost converter.
7. Study of Cycloconverter.
8. Simulation of single phase Half wave and Full wave rectifier circuit.
9. Simulation of controlled rectifier with R and RL load.
10. Simulation of controlled rectifier with (i) Source Inductance (ii) Freewheeling diode.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL703	Digital Signal Processing	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXL703	Digital Signal Processing	---	---	---	---	25	25	50

Instructions

1. Minimum 6 experiments and one course project must be submitted by each student.
2. Simulation tools like Matlab/Scilab can be used.
3. Processor based experiments/mini projects can be included.
   The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Tentative List of Experiments:

1. Study of Convolution, Series and Parallel Systems
2. Generation of Basic Signals
3. Computation of DFT and it's inverse
4. Computation of FFT and comparison of frequency response of DFT and FFT
5. Computation of DFT
6. IIR Butterworth filter design using IIT technique
7. IIR Chebyshev filter design using BLT technique
8. Design of FIR filter using hamming and hanning window, low pass and high pass filter

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	02	---	04	---	---	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDOLO7031	NEURAL NETWORKS & FUZZY LOGIC	---	---	---	---	25	25	50

Term Work:

The term work shall consist of

1. At least ***six experiments*** using MATLAB Or C/C++ or Java covering the whole of syllabus, duly recorded and graded.
2. ***One seminar and Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using C/C++ or Matlab or java

- Activation functions
- McCulloch Pitts Neuron Model
- Hebbian learning
- Single layer perceptron neural network
- Multi-layer perceptron neural network

- Error Back propagation neural network
- Kohonen Self-organizing Feature Maps
- Associative memory network
- Fuzzy relations
- Defuzzification methods

Suggested List of seminar :

- Classification of upper case and lower case letters.
- Classification of numbers 0-9.
- BPN for training a hidden layer.
- Implement a heteroassociative memory network to implement any pattern.
- Implement discrete Hopfield network for letters A-E.
- Implement BAM for a pattern of 5X3 array.
- Fuzzy Logic controller design – washing machine / vehicle speed control.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7032	Advanced Networking Technologies Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

1. Evaluation of home/campus network
2. GSM-GPS protocol implementation
3. Bluetooth protocol implementation
4. ZigBee protocol implementation
5. Wi-Fi protocol implementation
6. Study of NMAP
7. Study of SNMP
8. Study of Ethernet.

Suggested topics for presentation:

1. MANET
2. VOFR
3. VOIP
4. X.25
5. Body area network
6. RFID
7. Web Security
8. Compression Techniques
9. Security attacks
10. NAT
11. College campus network

12. Fiber Optics types, advantages disadvantages
13. WSN

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7033	Robotics	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7033	Robotics	-	-	-	-	25	--	25	50

Term Work:

The term work shall consist of

3. At least ***eight experiments*** using MATLAB / Scilab covering the whole of syllabus, duly recorded and graded.
4. ***Two assignments*** to be included covering at least 60% of the syllabus.

The distribution of marks for term work shall be as follows:

The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced *The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.*

Suggested List of experiments: using Matlab / Scilab

- Forward kinematics
- Inverse kinematic
- Dynamic analysis
- Joint-space trajectory
- Cartesian-space trajectory
- Template matching
- Iterative processing
- Segmentation

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXLDLO7034	IC Technology	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXLDLO7034	IC Technology	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation** on any one of the suggested topics. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested Experiments:

Following list of experiments covers the complete syllabus prescribed in IC Technology course. It is formulated in such a way that it allows student to explore various process, layout and device simulation tools. Detail analysis of observations should be recorded in the project book. Tools to be used are Microwind, SUPREME, Electric, Visual TCAD, Mentor Graphics Pyxis and tools available on nanohub. Linux based operating system is preferred to do simulations.

1. Draw and simulate layout for the CMOS inverter. Carry out static as well as transient simulation. Analyze CMOS inverter for i) $(W/L)_{pmos}>(W/L)_{nmos}$ ii) $(W/L)_{pmos}=(W/L)_{nmos}$ iii) $(W/L)_{pmos}<(W/L)_{nmos}$. Do parasitic extraction. Feed these parasitic in circuit simulator and do layout versus schematic verification.

2. Draw and simulate layout for the following circuits. Size them with respect to reference inverter.

   a. CMOS NAND
   b. CMOS NOR

Also observe the effect of different types of design rules on above circuits and tabulate the comparative results.

3. Draw and simulate layout for the given equation (each student will get different equation [y= $\overline{A.B + C.D}$]) with the following design style

   a. Static CMOS
   b. Transmission gate
   c. Dynamic Logic

4. Draw and simulate layout for 6T SRAM cell. Size the SRAM cell for 1) lowest area 2) high reliability

5. Draw and simulate layout for the following circuits.

a. SR latch

b. D flip Flop

6. Simulate oxidation process with Deal-Grove model for different conditions (e.g. oxidation type, orientation, time, temperature, thickness etc.) and comment on the results obtained.

7. Simulate diffusion process for different conditions (e.g. source, time, temperature, dopant etc.) and comment on the results obtained.

8. Simulate Si PN junction for various structure and environmental conditions and comment on the results obtained. Repeat the entire simulation for Ge diode.

9. Simulate MOS capacitor (Classical Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

10. Simulate MOS capacitor (Quantum Simulation) for single gate device for a typical value of fixed charge density and interface trap charge density in gate insulator. Do the AC analysis and comment on the results obtained.

Suggested topics for presentation:

Presentation on any Novel device or process.

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04	--	---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04	--	---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04	--	---	04	---	---	04
ILO802X	Institute Level Optional course II#	03	---	---	03	---	---	03
ELXL801	Internet of Things Lab.		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Lab.		02			01	---	01
ELXL803	Project-II	---	12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Lab.		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**9**	---	**24**

Course Code	Course Name	Examination Scheme – Semester VIII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Lab.						25	25	50
ELXL802	Analog and Mixed VLSI Design Lab.						25	25	50
ELXL803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Lab.						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[*]
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

B.E. (Electronics Engineering) – Semester VIII

`Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX 801	Internet of Things	4	2	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELX 801	Internet of Things	20	20	20	80	-	--	--	100

Course Pre-requisite: ELX 501 :- Micro-controllers and Applications
ELX 601:- Embedded System and RTOS
ELX602:- Computer Communication Network
ELXDLO-2 Wireless Communication

Course Objectives:

The objectives of this course are to:

1. Understand the design features of Internet of Things(IoT)
2. Understand importance of data handling in IoT Way.
3. Introduce multiple way of data communication and networking.
4. Understand design issue in IoT

Course Outcomes:

On successful completion of the course the students will be able to:

1. Understand the concepts of Internet of Things
2. Analyze basic web connectivity in IoT
3. Understand Data handling in IoT
4. Design basic applications based on IoT using specific components

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to IoT**	**08**
	1.1	**Introduction;-**Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, and M2MCommunication.	
	1.2	**Iot and M2m:-** IoT/M2M System layers and Design Standardization, Difference between IoT and M2M	
2.		**Network & Communication aspects**	**10**

	2.1	**Design Principles & Web Connectivity:-** Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets (Publish –Subscribe),MQTT, AMQP, CoAP Protocols	
	2.2	**Internet Connectivity: -** Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals :LORA ,NBIoT,CAT LTE M1,SIGFOX	
3.0		**IoT Platforms and Design Methodology**	**08**
	3.1	**Defining Specifications About:-** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, (case studies)	
	3.2	**IoT Levels:-**IoT Levels and Deployment Templates	
4.0		**Data Handling in IoT**	**10**
	4.1	**Data Acquiring, Organizing, Processing:-** Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	
	4.2	**Data Collection and Storage:-** Cloud Computing Paradigm for Data Collection, storage and computing, Cloud Service Models, Xively Cloud for IoT (AWS ,Google APP engine ,Dweet.IO, Firebase)	
5.0		**Components of IoT**	**06**
	5.1	**Exemplary Devices:-** Raspberry Pi, R-Pi Interfaces, Programming R-Pi, Sensor Technology, Sensor Data Communication Protocols, RFID, WSN Technology, Intel Galileo	
6.0		**IoT Case Studies**	**06**
	6.1	Design Layers, complexity, IoT Applications in Premises, Supply Chain and Customer Monitoring.	
	6.2	Home Automation, Smart Cities, Environment, Agriculture, IoT Printer	
		Total	**48**

Recommended Text Books:

5. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
6. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition
7. David Hanes ,Gonzalo salgueiro"IoT Fundamentals Networking Technologies,Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition
8. Andrew Minteer ,"Analytics for the Internet of Things(IoT)",Kindle Edition

Reference Books:

1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition
2. Yashavant Kanetkar , Shrirang Korde :Paperback "21 Internet of Things (IOT) Experiments"
    a. BPB Publications

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of thesyllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	T/W Practical	Tutorial	Total
ELX802	Analog and Mixed VLSI Design	04	02	-	04	-	-	04

		Examination Scheme								
		Theory Marks				Exam Duration (Hrs)	Term work	Practical	Oral	Total
		Internal Assessment Marks			End Sem Exam (Marks)					
		Test 1	Test 2	Average						
ELX802	Analog and Mixed VLSI Design	20	20	20	80	03	-	-	-	100

Course Pre-requisite:

- ELX302: Electronic Devices and Circuits I
- ELX303: Digital Circuit Design
- ELX402: Electronic Devices and Circuits II
- ELX504: Design With Linear Integrated Circuits
- ELX603: VLSI Design
- ELX DLO-3: IC Technology

Course Objectives:

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.
3. To emphasize upon the issues related to mixed signal layout design.

Course Outcomes:

After successful completion of the course student will be able to

1. Discuss tradeoffs involved in analog VLSI Circuits.
2. Analyze building blocks of CMOS analog VLSI circuits.
3. Design building blocks of CMOS analog VLSI circuits
4. Carry out verifications of issues involved in analog and mixed signal circuits

Module No	Unit No	Topics	Hrs
1. 0		**Analog building blocks**	8
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks,current mirror.	
	1.2	**Voltage References:** Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT	

		current generation and Constant Gm biasing	
2.0		**Amplifier Fundamentals**	
	2.1	**Single Stage Amplifiers**: Basic concepts, Gain Bandwidth (GBW), Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage.	12
	2.2	**Differential Amplifiers:** Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.	
	2.3	**Noise:** Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise in differential pairs, noise bandwidth, noise figure, noise temperature.	
3.0		**MOS Operational Amplifiers**	
	3.1	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps	8
	3.2	**Op-amp Design:** General Considerations, performance parameters, One-stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations(ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps	
4.0		**Mixed Signal Circuits**	
	4.1	**Basic Concepts:** AMS design flow, ASIC, Full custom design, Semi-custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	8
	4.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO,	
	4.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
5.0		**Data Converter Fundamentals**	
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non- inverting amplifier and integrator.	4
	5.2	Basic CMOS comparator Design, Adaptive biasing, Analog multipliers.	
6.0		**Data Converter Fundamentals and Architectures**	
	6.1	**Fundamentals:** Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	8
	6.2	**DAC architectures:** Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC **ADC architectures:** Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs	
		Total	**48**

Recommended Books:

1. B Razavi, "*Design of Analog CMOS Integrated Circuits*", Tata McGraw Hill, 1st Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, "*CMOS Circuit Design, Layout, and Simulation*", Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, "*CMOS Analog Circuit Design*", Oxford University Press, 3rd Edition.
4. Gray, Meyer, Lewis, Hurst, "*Analysis and design of Analog Integrated Circuits*", Willey, 5th Edition

Internal Assessment (IA)

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8041	Advanced Power Electronics	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8041	Advanced Power Electronics	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

4. Power Electronics.
5. Linear Control System.
6. BEE

Course Objectives:

3. To enhance the ideas of students for more complex power electronic system.
4. To teach the analytical methods in power electronic systems.
5. To expose the students to various applications of power electronics in electronics equipment, drives and non-conventional energy systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Thoroughly understand the modern methods of analysis and control of power electronic systems.
2. Carry out the theoretical analysis of the power electronic systems from the 'Systems Theory' point of view.
3. Appreciate the ubiquity of power electronic systems in engineering fields.
4. Simulate and analyse power electronic systems.

Module No.	Unit No.	Contents	Hrs.
1		**Three-phase Rectifiers**	8
	1.1	3-phase half-wave and full-wave controlled rectifiers with R and RL load, Effect of source inductance,	
	1.2	Distortion in line current, calculation of performance parameters.	
2		**Three-phase inverters and control**	8
	2.1	Three phase bridge inverters (120° and 180° conduction mode) with R and RL load	
	2.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
3		**DC-DC Converters**	10
	3.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters.	
	3.2	Feedback control of these converters (PI and PID).	
4		**Power Electronic Applications in DC Drives**	8
	4.1	Introduction to DC motors, speed control of DC motor, drives with semi converters, full converters and dual converters.	
	4.2	Chopper-based drive.	
	4.3	Electric braking of DC motors.	
5		**Power Electronic Applications in AC Drives**	10
	5.1	Introduction to three-phase induction motor, speed control methods for three-phase induction motor : i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Slip power recovery schemes	
6		**Power Electronic Applications**	4
	6.1	Induction heating, dielectric heating, solid state relays,	

	6.2	Energy conversion interface in renewable energy system.	
Total			**48**

Recommended Books:

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3rd Edition.
2. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2nd Edition.
3. Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2nd Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2nd Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX DLO8042	MEMS Technology	04	02	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ELX DLO8042	MEMS Technology	20	20	20	80	03	--	--	--	100

Course Pre –requisite: VLSI Design an IC Technology

Course Objectives:

1. To provide knowledge of MEMS processing steps and processing modules
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and structures.

Course Outcomes:

1. Understand the underlying fundamental principles of MEMS devices including physical operation and material properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of micro system sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to MEMS**	4
	1.1	Introduction to MEMS, Comparison with Micro Electronics Technology,	
	1.2	Real world examples (Air-Bag, DMD, Pressure Sensors), MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications	
2		**MEMS Materials and Their Properties**	8
	2.1	Materials (eg. Si, SiO_2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt)	
	2.2	Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.	
3		**MEMS Sensors, Actuators and Structures**	8
	3.1	MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	
	3.2	Micro Actuation Techniques (Thermal, Piezo electric, Electro static, Shape Memory Alloys, **LORENTZ FORCE ACTUATION**), Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps.	
4		**MEMS Fab Processes**	10
	4.1	MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio Micro	
	4.2	Machining (LIGA, Laser), X-Ray Lithography, Photolithography, PVD techniques, Wet, Dry, Plasma	
	4.3	etching, DRIE, Etch Stop Techniques. Die, Wire & Wafer Bonding, Dicing, Packaging(with Metal	
5		**MEMS Devices**	12
	5.1	Architecture, working and basic behaviour of Cantilevers, Micro heaters, Accelerometers, Pressure Sensor types, Micromirrors in DMD, Inkjet printer-head. Steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	6

	6.1	Piezo-resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior	
	6.2	MEMS Failure Mechanisms and Reliability.	
Total			**48**

Recommended Books:

1. MEMS and MICROSYSTEMS Design and Manufacture by Tai Ran Hsu : McGraw Hill Education
2. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
3. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
4. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
5. Micro-system Design - by S. Senturia; Publisher: Springer
6. Analysis and Design Principles of MEMS Devices - MinhangBao; Publisher: Elsevier Science
7. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2 edition
8. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4.Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8043	Virtual Instrumentation	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation	20	20	20	80	-	-	100

Rationale :- Virtual instrumentation combines mainstream commercial technologies such as the PC, with flexible software and a wide variety of measurement hardware, so one can create user-defined systems that meet their exact application needs. Virtual instrumentation has led to a simpler way of looking at measurement systems. Instead of using several stand-alone instruments for multiple measurement types and performing rudimentary analysis by hand, engineers now can quickly and cost-effectively create a system equipped with analysis software and a single measurement device that has the capabilities of a multitude of instruments for various applications & measurements.

Course Objectives :-

1. To understand virtual instrumentation (VI) & to realize its architecture
2. To familiarize with VI software & learn programming in VI
3. To study various instruments interfacing & data acquisition methods
4. To understand various analysis tools & develop programs for different measurement applications

Course Outcomes :-

At the end of the course, students should gain the ability to :-

- **CO-1 :-** Explain the concepts of virtual instrumentation
- **CO-2 :-** Select the proper data acquisition hardware
- **CO-3 :-** Configure the data acquisition hardware using LabVIEW
- **CO-4 :-** Use LabVIEW to interface related hardware like transducers
- **CO-5 :-** Design virtual instruments for practical applications

Module No.	Topics	Hours
1	**INTRODUCTION TO VIRTUAL INSTRUMENTATION (VI)**	06
1.1	Historical perspective – Need for VI – Advantages of VI – Definition of VI – Block diagram & architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming	
2	**PROGRAMMING TECHNIQUES**	08
2.1	VI & sub-VI – Loops & charts – Arrays – Clusters – Graphs – Case & sequence structures – Formula nodes – Local & global variables – String & files inputs	
3	**APPLICATION DEVELOPMENT SOFTWARE (LabVIEW)**	10
3.1	Creating virtual instrument in LabVIEW – Implementing dataflow programming in LabVIEW – VI, sub-VI & modular code creation in LabVIEW – Arrays & file I/O in LabVIEW – Textual math integration in LabVIEW – Interfacing external instruments to PC using LabVIEW	
4	**DATA ACQUISITION BASICS**	08
4.1	Digital I/O – Counters & timers – PC hardware structure – Timing – Interrupts – DMA – Software & hardware installation – IEEE GPIB 488 concepts – Embedded system buses – PCI – EISA – CPCI	
5	**COMMON INSTRUMENT INTERFACES**	08
5.1	Current loop – RS 232C / RS 485 – Interface basics – USB – PCMCIA – VXI – SCXI – PXI – Networking basics for office & industrial application VISA & IVI – Image acquisition & process – Motion control – Digital multimeter (DMM) – Waveform generator	
6	**USING ANALYSIS TOOLS & APPLICATION OF VI**	08
6.1	Fourier transform – Power spectrum – Correlation method – Windowing & filtering – Pressure control system – Flow control system – Level control system – Temperature control system – Motion control employing stepper motor – PID controller toolbox	
1 – 6	**TOTAL**	48

Recommended Books :-

1. Dr. Sumathi S. & Surekha P, LabVIEW Based Advanced Instrumentation System, PHI, 2nd edition (2007)
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, 2nd edition (2006)
3. Lisa K. Wells & Jeffrey Travis, LabVIEW for Everyone, PHI, 3rd edition (2009)

4. Robert H. Bishop, Learning with LabVIEW 7 Express, Pearson Education, 1st edition (2005)
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2nd edition (2010)

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8044	Digital Image Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Examination			
		Test I	Test II	Average				
ELXDLO 8044	Digital Image Processing	20	20	20	80	-	-	100

Course Pre-requisite:

- Applied Mathematics
- Signals and Systems

Course Objectives:

1. To learn the fundamental concepts of Digital Image Processing through basic spatial and frequency domain techniques.
2. To learn Image Compression and Decompression Techniques and compression standards.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of Digital Image representation and simple pixel relations.
2. Explain spatial domain and frequency domain techniques for digital image enhancement.
3. Perform segmentation and morphological operations.
4. Apply compression and decompression techniques to different digital images.

Module No.	Unit No.	Topics	Hrs.
1		**Digital Image Processing Fundamentals**	04
	1.1	**Introduction:** Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	**Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Model, Two dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels,	
		Image File Formats : BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	
2		**Image Enhancement in Spatial Domain**	08
	2.1	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging,	
		Spatial domain filters: Smoothing Filters, Sharpening Filters,High boost filter	
3		**Image Segmentation and Representation**	08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique	
	3.2	Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Two Dimensional Moments.	
4		**Binary Image Processing**	06
	4.1	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling	
5		**Image Transforms and frequency domain processing**	12
	5.1	Introduction to 2 Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform(FFT), Computation of 2 DFFT	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete	

		Cosine Transform(DCT), Introduction to Discrete Wavelet Transform (DWT)	
	5.3	Enhancement in the frequency domain: Frequency Domain Filtering Lowpass Filtering, Highpass Filtering, Homomorphic Filtering, Generation of Spatial Masks from Frequency Domain Specifications	
6		**Image Compression:**	10
	6.1	Fundamentals :Coding Redundancy, Interpixel Redundancy, Psycho visual	
		Redundancy	
	6.2	Image Compression Models :The Source Encoder and Decoder, Lossless	
		Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman	
		Coding, Differential PCM,	
	6.3	Lossy Compression Techniques: Predictive Coding, Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1. , Fidelity Criteria.	
Total			**48**

Text Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Second Edition, Thomson Learning, 2001
3. William K. Pratt, "Digital Image Processing", Third Edition, John Wiley & Sons, Inc., 2001

Internal Assessment (IA) :-

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination :-

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Q.1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q.2 to Q.6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

e Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	8

	GANTT chart. Introduction to Project Management Information System (PMIS).	
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;	09

	Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Enterpreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,	08

	Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-	7

	making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	10

	Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship	08

	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**

03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	07

	of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books

9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 801	Internet of Things Laboratory	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 801	Internet of Things Laboratory	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:
(Programming using C, Embedded C, Pyhton is to be encouraged)

1. Minimum two Experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for data handling and storage.
2. Minimum three experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) for interfacing various sensors and communicating data using Internet using various Protocols.
3. Minimum two experiments using any hardware platform (Arduino/Raspberry Pi/BeagleBone/Galileo) and wireless communication protocol (802.11 and 802.14.5 IEEE standard)
4. Minimum one experiment using Cloud Storage.

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL 802	Analog and Mixed VLSI Design	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXL 802	Analog and Mixed VLSI Design	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

Use of Online Tools to study analog VLSI circuits

2. Analysis of MOSFETs for analog performance

3. Design and simulate various types of current mirror circuits

4. Design and simulate various common source amplifier circuits

5. Design and simulate various types of single stage amplifiers

6. Design and simulate differential amplifier

7. Design and simulate operational tran-sconductance amplifier

8. Design and simulate switch capacitor circuits

9. Design and simulate various types of oscillators

10. Design and simulate mixed mode circuit

11. Generate layout for the simple and cascode current mirror

12. Generate layout for common source amplifier

13. Generate layout for the differential amplifier

14. Generate layout for the Oscillator

15. Generate layout for Phase Detector

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit proper report covering the latest advances in the field of Mixed VLSI Design.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8041	Advanced Power Electronics Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8041	Advanced Power Electronics Lab.	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

1. Single Phase Full Controlled Bridge Rectifier.
2. Speed control of Separately excited DC motor using Armature Voltage Control
3. Speed control of 3-phase Induction Motor using V/F control.
4. Simulation of 3-phase fully controlled Bridge rectifier with R and RL load.
5. Simulation of 1-phase fully controlled Bridge rectifier and study of various parameters.
6. Simulation of 1-phase Inverter and study of various Performance parameters.
7. Simulation of SVM Inverter.
8. Simulation of Closed loop dc-dc converter
9. Study High Frequency Induction heating & Dielectric heating.
10. Study of operation and control of solid state relays.

Suggested topics for Case Study:

Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering design issues, hardware and software details and applications.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO 8042	MEMS Technology Lab.	-	2	--	-	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ELXDLO 8042	MEMS Technology Lab.	-	-	-	-	25	--	25	50

Course Objectives:

Lab session includes **seven experiments plus one presentation on case study.** The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested Experiments:

1. Design electro-statically actuated cantilever
2. Design bimorph cantilever which act as pressure sensor.
3. Dynamic analysis of Beam
4. Find the tip deflection of the cantilever with different types of load
5. Find the tip deflection of the cantilever in sweep analysis
6. Model and simulate Electro-mechanical actuator. Do dc and transient analysis
7. Design the geometry of MEMS and find performance characteristics such as resonant frequency, deflection per voltage or temperature
8. Simulate the harvested electrical power from mechanical vibrations using piezoelectric cantilever beam
9. Model and simulate of accelerometer
10. Case study of MEMS based device

Suggested topics for Case Study:
Faculty members can suggest topics pertaining above syllabus and ask students to submit complete report covering fabrication issues, materials, characterization and applications of the MEMS devices.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8043	Virtual Instrumentation Laboratory	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8043	Virtual Instrumentation Laboratory	--	--	--	--	25	25	50

Term Work :-

At least 6 experiments covering entire syllabus of ELXDLO8043 (Virtual Instrumentation) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Virtual Instrumentation need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced

Suggested List of Experiments :-

1. Verification of arithmetic operations
2. Verification of Boolean Expressions / half-adder & full-adder
3. Implementation of array functions
4. Program to convert Celsius into Fahrenheit & vice-versa
5. Program for implementing seven segment display
6. Program for calculating body mass index (BMI) using cluster

7. Program to control temperature using thermistor / RTD & DAQ
8. Program to control liquid flow using DAQ
9. Program to control liquid level using DAQ
10. Program to control pressure using DAQ
11. Program for DC motor speed control using PID toolbox

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXDLO8044	Digital Image Processing	--	02	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal Assessment (IA)			End Semester Exam			
		Test I	Test II	Average				
ELXDLO8044	Digital Image Processing	--	--	--	--	25	25	50

Term Work :-

At least 7 experiments covering entire syllabus of ELXDLO8044 (Digital Image Processing) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. One presentation on a case study based on the topic in Digital Image Processing need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL704 ELXL803	Project I Project II	-	06 12	--	-	03 06	--	09

Objectives:

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research Outcomes

Outcome:

Learner will be able to:

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution is to be validated with proper justification and the report needs to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization
d) Clarity of objective and scope
e) Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

a) Quality of problem selected
b) Clarity of Problem definition and Feasibility of problem solution
c) Relevance to the specialization / Industrial trends
d) Clarity of objective and scope
e) Quality of work attempted
f) Validation of results
g) Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai Students should be motivated to publish a paper in Conferences/students competitions based on the work

Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date 02-07-2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
ECC302	Electronic Devices & Circuits	3	--	--	3	--	--	3
ECC303	Digital System Design	3	--	--	3	--	--	3
ECC304	Network Theory	3	--	1	3	--	1	4
ECC305	Electronic Instrumentation & Control Systems	3	--	--	3	--	--	3
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1
ECL302	Digital System Design Lab	--	2	--	--	1	--	1
ECL303	Electronic Instrumentation & Control Systems Lab	--	2	--	--	1	--	1
ECL304	Skill Lab: C++ and Java Programming	--	4	--	--	2	--	2
ECM301	Mini Project 1A	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

*** Should be conducted batch wise.**
$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ECC302	Electronic Devices & Circuits	20	20	20	80	3	--	--	100
ECC303	Digital System Design	20	20	20	80	3	--	--	100
ECC304	Network Theory	20	20	20	80	3	25	--	125
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	3	--	--	100
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	--	25	25	50
ECL302	Digital System Design Lab	--	--	--	--	--	25	--	25
ECL303	Electronic Instrumentation & Control Systems Lab	--	--	--	--	--	25	--	25
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	--	25	25	50
ECM301	Mini Project 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
ECC402	Microcontrollers	3	--	--	3	--	--	3
ECC403	Linear Integrated Circuits	3	--	--	3	--	--	3
ECC404	Signals & Systems	3	--	1	3	--	1	4
ECC405	Principles of Communication Engineering	3	--	--	3	--	--	3
ECL401	Microcontrollers Lab	--	2	--	--	1	--	1
ECL402	Linear Integrated Circuits Lab	--	2	--	--	1	--	1
ECL403	Principles of Communication Engineering Lab	--	2	--	--	1	--	1
ECL404	Skill Lab: Python Programming	--	4	--	--	2	--	2
ECM401	Mini Project 1B	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**7**	**2**	**24**

*** Should be conducted batch wise.**

$ Indicates work load of a learner (Not Faculty) for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ECC402	Microcontrollers	20	20	20	80	3	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ECC404	Signals & Systems	20	20	20	80	3	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	3	--	--	100
ECL401	Microcontrollers Lab	--	--	--	--	--	25	--	25
ECL402	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50
ECL404	Skill Lab: Python Programming	--	--	--	--	--	25	25	50
ECM401	Mini Project 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC301	Engineering Mathematics-III	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications.
2. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.
3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra.
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: After successful completion of course student will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5. Use matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t,* Laplace Transform of derivatives and integrals (Properties without proof). Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	7
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7
05	**Module: Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Module: Vector Differentiation and Integra**l 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational (conservative) vector	6

	fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	
Total		39

References:

1. Advanced engineering mathematics, H.K. Das, S . Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment Test (20-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits	3	-	--	3	--	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC: 102 - Engineering Physics-I
FEC: 201 - Engineering Physics-II
FEC:105 - Basic Electrical Engineering

Course Objectives:

1. To explain functionality different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers.
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and it's applications in Operational Amplifiers

Course Outcomes:

After successful completion of the course student will be able to:

1. Know functionality and applications of various electronic devices.
2. Explain working of various electronics devices with the help of V-I characteristics.
3. Derive expressions for performance parameters of BJT and MOSFET circuits.
4. Evaluate performance of Electronic circuits (BJT and MOSFET based).
5. Select appropriate circuit for given application.
6. Design electronic circuit (BJT, MOSFET based) circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Electronic Devices**	**05**
	1.1	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator.	
	1.2	Construction, working and characteristics of BJT, JFET, and E-MOSFET	
2.0		**Biasing Circuits of BJTs and MOSFETs**	**06**
	2.1	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias)	
	2.2	DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for JFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	
3.0		**Small Signal Amplifiers**	**06**
	3.1	Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifier using hybrid pi model.	
	3.2	Small signal analysis (Zi, Zo, Av) of CS (for EMOSFET) amplifiers.	
	3.3	Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	
4.0		**Frequency response of Small signal Amplifiers:**	**08**
	4.1	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance.	
	4.2	High and low frequency analysis of CE amplifier.	
	4.3	High and low frequency analysis of CS (E-MOSFET) amplifier.	
5.0		**Large Signal Amplifiers:**	**06**
	5.1	Difference between small signal & large signal amplifiers. Classification and working of Power amplifier	
	5.2	Analysis of Class A power amplifier (Series fed and transformer coupled).	
	5.3	Transformer less Amplifier: Class B power amplifier. Class AB output stage with diode biasing	
	5.4	Thermal considerations and heat sinks.	
6.0		**Introduction to Differential Amplifiers**	**08**
	6.1	E-MOSFET Differential Amplifier, DC transfer characteristics, operation with common mode signal and differential mode signal	
	6.2	Differential and common mode gain, CMRR, differential and common mode Input impedance.	
	6.3	Two transistor (E-MOSFET) constant current source	
		Total	**39**

Text books:

1. D. A. Neamen, “Electronic Circuit Analysis and Design,” Tata McGraw Hill, 2ndEdition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, “Microelectronic Circuits Theory and Applications,” International Version, OXFORD International Students, 6thEdition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

References:

1. Boylestad and Nashelesky, “Electronic Devices and Circuits Theory,” Pearson Education, 11th Edition.
2. A. K. Maini, “Electronic Devices and Circuits,” Wiley.
3. T. L. Floyd, “Electronic Devices,”Prentice Hall, 9th Edition, 2012.
4. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

NPTEL/ Swayam Course:

1. Course: Analog Electronic Circuit By Prof. Shouribrata chatterjee (IIT Delhi); https://swayam.gov.in/nd1_noc20_ee89/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC303	Digital System Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC105 – Basic Electrical Engineering

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
3. To analyze, design and implement logical operations using various sequential logic circuits.
4. To study the characteristics of memory and their classification.
5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand types of digital logic, digital circuits and logic families.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design and implement sequential logic circuits.
4. Develop a digital logic and apply it to solve real life problems.
5. Classify different types of memories and PLDs.
6. Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Module No.	Unit No.	Topics	Hrs.
1.0		**Number Systems and Codes**	**04**
	1.1	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	04
2.0		**Logic Family and Logic Gates**	**05**
	2.1	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	03
	2.2	Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem	02
3.0		**Combinational Logic Circuits**	**12**
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	04
	3.2	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator	04
	3.3	Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder	04
4.0		**Sequential Logic Circuits**	**12**
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register	04
	4.2	Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter	04
	4.3	Applications of Sequential Circuits: Frequency division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits	04
5.0		**Different Types of Memories and Programmable Logic Devices**	**04**
	5.1	Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	02
	5.2	Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	02
6.0		**Introduction to VHDL**	**02**
	6.1	Basics of VHDL/Verilog Programming, Design and implementation of adder, subtractor, multiplexer and flip flop using VHDL/Verilog	02
		Total	**39**

Text Books:

1. John F. Warkerly, “Digital Design Principles and Practices”, Pearson Education, Fifth Edition (2018).
2. Morris Mano, Michael D. Ciletti, “Digital Design”, Pearson Education, Fifth Edition (2013).
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill Education, Forth Edition (2010).
4. A. Anand Kumar, “Fundamentals of Digital Circuits”, PHI, Fourth Edition (2016).
5. Volnei A. Pedroni, “Digital Electronics and Design with VHDL” Morgan Kaufmann Publisher, First Edition (2008).
6. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, Third Edition, MGH (2014).

Reference Books:

1. Thomas L. Floyd, “Digital Fundamentals”, Pearson Prentice Hall, Eleventh Global Edition (2015).
2. Mandal, “Digital Electronics Principles and Applications”, McGraw Hill Education, First Edition (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “Digital Systems Principles and Applications”, Ninth Edition, PHI (2009).
4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, “Digital Principles and Applications”, The McGraw Hill, Eight Edition (2015).
5. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic Design with VHDL”, Second Edition, TMH (2009).
6. J. Bhasker, “A Verilog HDL Primer”, Star Galaxy Press, Third Edition (1997).

NPTEL / Swayam Course:

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Network Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of Test 1 and Test 2					
ECC304	Network Theory	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. FEC105 - Basic Electrical Engineering
2. FEC201 - Engineerring Mathematics II

Course Objectives:

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Evaluate circuit using graph theory.
4. Find the various parameters of two port network.
5. Apply network topology for analyzing the circuit.
6. Synthesize the network using passive elements.

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrical circuit analysis**	**08**
	1.1	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using mesh analysis (for Two Loops only).	
2.0		**Graph Theory**	**06**
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	
3.0		**Time and frequency domain analysis**	**07**
3.0	**3.1**	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals.	
	3.2	Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	
4.0		**Network functions**	**06**
	4.1	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by graphical methods, testing for Hurwitz polynomial.	
	4.2	Analysis of ladder & symmetrical lattice network (Up to two nodes or loops)	
5.0		**Two port Networks**	**05**
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	
	5.2	Interconnections of Two-Port networks T & π representation.	
6.0		**Synthesis of RLC circuits**	**07**
	6.1	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions.	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms (Up to Two Loops only).	
		Total	**39**

Textbooks:

1. Franklin F Kuo, “Network Analysis and Synthesis”, Wiley Toppan, 2nd ed. ,1966.
2. M E Van Valkenburg, “Network Analysis”, Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

Reference Books:

1. A. Chakrabarti*, “Circuit Theory”,* Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli “Circuits and Networks”, Tata McGraw-Hill education.
3. Smarajit Ghosh “Network Theory Analysis & Synthesis”, PHI learning.
4. K.S. Suresh Kumar, “Electric Circuit Analysis” Pearson, 2013.
5. D. Roy Choudhury, “Networks and Systems” , New Age International, 1998.

NPTEL / Swayam Course:

1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras); https://swayam.gov.in/nd1_noc20_ee64/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least **10 assignments** covering entire syllabus must be given during the **“Class Wise Tutorial”**. The assignments should be students’ centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC305	Electronic Instrumen-tation & Control Systems	20	20	20	80	03	--	--	100

Course pre-requisites:

1. FEC105 – Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and transducers
2. To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcomes:

After successful completion of the course student will be able to:

1. Identify various sensors, transducers and their brief performance specification.
2. Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry
3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems.
4. Obtain the transfer functions for a given Control system.
5. Understand the analysis of systems in time domain and frequency domain.
6. Predict stability of given system using appropriate criteria.

Module No.	Unit No.	Topics	Hrs.
1		**Principle of Measurement, Testing and Measuring instruments**	04
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge	
2		**Sensors and Transducers**	06
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers (LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors (RTD). Thermistors and thermocouples, their ranges and applications	
3		**Introduction to control system Analysis**	08
	3.1	Introduction: Open and closed loop systems, example of control systems	
	3.2	Modelling: Modelling, Transfer function model	
	3.3	Block diagram reduction techniques and Signal flow graph	
4		**Response of control system**	04
	4.1	Dynamic Response: Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
	4.2	Concept of lag and lead compensator.	
5		**Stability Analysis in Time Domain**	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system	
6		**Stability Analysis in frequency domain**	09
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin	
Total			39

Textbooks:

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS .India
2. B.C Nakra, K.K. Cahudhary, Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
3. W.D. Cooper, "*Electronic Instrumentation And Measuring Techniques"* –PHI
4. Nagrath, M.Gopal, "*Control System Engineering*", Tata McGrawHill.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed.,2004.
6. K.Ogata, "*Modern Control Engineering*, Pearson Education", IIIrd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques"* –PHI
2. M.M.S. Anand, "*Electronic Instruments and instrumentationTechnology"*.
3. Gopal M., "Control Systems Principles and Design", Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
4. Benjamin C.Kuo, "*Automatic Control Systems*, Eearson education", VIIthedition
5. Doeblin E.D., Measurement system, Tata Mc Graw Hill., 4th ed, 2003.Madan Gopal, "Control Systems *Principles and Design"*, Tata McGraw hill, 7th edition,1997.
6. Normon, "*Control System Engineering"*, John Wiley & sons, 3rdedition.

NPTEL/ Swayam Course:

1. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with equipments and measuring instruments used to perform Electronics Devices and Circuits laboratory work.
2. To provide hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.
3. To develop an ability among students to gather appropriate data and analyse the same to relate theory with practical.
4. To develop trouble shooting abilities among students.

Course Outcomes:

After successful completion of the course students will be able to:

1. Know various equipments, electronics devices and components, and measuring instruments used to perform laboratory work.
2. Students will be able to explain functionality of various equipments, electronics devices and components and neasu6 instruments used to perform laboratory work.
3. Students will be able connect various equipments, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4. Students will able to perform experiment to gather appropriate data.
5. Students will able to analyze data obtained from experiment to relate theory with experiment results.
6. Students will able to prepare laboratory report (Journal) to summarise the outcome each experiment.

Laboratory plan:

Maximum of 10 practicals including minimum 2 to 3 simulations should be conducted. Suggested list of experiments:

1. To study of pn junction diode characteristics.
2. To study zener as a voltage regulator.
3. To study characteristics of CE configuration.
4. To study BJT biasing circuits.
5. To study BJT as CE amplifier.
6. To study frequency response of CE amplifier.
7. To study EMOSFET biasing circuits.
8. Simulation experiment on study of CS amplifier.
9. Simulation experiment on study frequency response of CS amplifier.
10. Simulation experiment on study of differential amplifier.
11. Simulation experiment on multistage amplifier.

Term Work: At least 10 Experiments including not more than 03 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL302	Digital System Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL302	Digital System Design Lab	--	--	--	--	25	--	25

Course objectives:

1. To get familiarise with basic building blocks of Digital System Design and verify the operation of various digital ICs.
2. To train students to design and implementation of combinational circuits.
3. To instruct students on how to design and implement sequential circuits.
4. To introduce simulation software like VHDL/Verilog to design basic digital circuits.

Course outcomes:

Learners will be able to …

1. Identify various Digital ICs and basic building blocks of digital system design
2. Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3. Identify and understand working of various types of flip flops and their inter conversions.
4. Design and implement basic sequential circuits such as counters, registers etc.
5. Acquire basic knowledge of VHDL/Verilog basic programming.

Suggested list of experiments:

1. Simplification of Boolean functions.
2. Design AND, OR, NOT, EXOR, EXNOR gates using Universal gates: NAND and NOR.
3. Implement digital circuits to perform Binary to Gray and Gray to Binary operations.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Design and implement BCD adder using 4-bit Binary Adder IC-7483.
6. Implement logic equations using Multiplexer.
7. Verify encoder and decoder operations.

8. Design and implement Magnitude Comparator.
9. Verify truth table of different types of flip flops.
10. Flip flop conversions JK to D, JK to T and D to TFF.
11. Design asynchronous/synchronous MOD N counter using IC7490.
12. Verify different counter operations.
13. Write VHDL/Verilog simulation code for different logic gates.
14. Write VHDL/Verilog simulation code for combinational and sequential circuits.
15. Write VHDL/Verilog simulation code for 4:1 Multiplexer, 2 to 4 line binary decoder.

Term Work:

At least 08 experiments covering the entire syllabus must be given "**Batch Wise"**. Out of these, **06 hardware experiments**, to be done strictly on breadboard and **at least 02 software experiments** using VHDL/Verilog. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **"Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Pract.	Tut.	Total
ECL303	Electronic Instrumentation & Control Systems Lab.	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam			
ECL303	Electronic Instrumentation & Control Systems Lab.	--	--	--	--	25	--	25

Course Objectives:

1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance.
2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement.
3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems.
4. To examine steady-state and frequency response of first and second order electrical systems.
5. To inspect stability analysis of system using Root locus, Bode plot, polar plot and Nyquist plot.

Course Outcomes:

After successful completion of the course student will be able to:

1. Plot and validate the performance characteristics of transducers.
2. Validate the characteristics of various temperature, pressure and level transducers.
3. Plot frequency response of first-order electrical system.
4. Plot time response of second-order electrical system and calculate the steady-state error.
5. Validate the effect of damping factor on the response of second order system.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

List of experiments:

1. Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
2. Designing AC bridge Circuit for capacitance measurement.
3. Study and characteristics of Resistive Temperature Detector (RTD).
4. Study of Linear Variable Differential Transformer (LVDT)
5. To plot the effect of time constant on first-order systems response.
6. To plot the frequency response of first-order System
7. To plot the time response of second-order systems
8. To plot the frequency response of second-order System
9. To Examine Steady State Error for Type 0, 1, 2 System
10. To study the performance of Lead and Lag Compensator
11. To inspect the relative stability of systems by Root-Locus using Simulation Software.
12. To determine the frequency specification from Polar plot of system
13. To inspect the stability of system by Nyquist plot using Simulation software.
14. To inspect the stability of system by Bode plot using Simulation software.
15. Any other experiment based on syllabus which will help students to understand topic/concept.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per **“Credit and Grading System”** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL304	Skill Lab: C++ and Java Programming	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks						
		Internal assessment			End Sem. Exam	Term Work	Practical And Oral	Total
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	25	25	50

Note: Before performing practical **'Necessary Theory'** will be taught by concern faculty

Course Pre-requisites:

1. FEL204 - C-Programming

Course Objectives:

1. Describe the principles of Object Oriented Programming (OOP).
2. To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3. Utilize the object-oriented paradigm in program design.
4. To lay a foundation for advanced programming.
5. Develop programming insight using OOP constructs.

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe the basic principles of OOP.
2. Design and apply OOP principles for effective programming.
3. Develop programming applications using OOP language.
4. Implement different programming applications using packaging.
5. Analyze the strength of OOP.
6. Percept the Utility and applicability of OOP.

Module No.	Unit No.	Topics	Hrs.
1.0		**C++ Overview**	**08**
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object oriented programming language.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2.0		**C++ Control Structures**	**08**
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.	
3.0		**Object-Oriented Programming using C++**	**12**
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4.0		**Introduction to Java**	**06**
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5.0		**Inheritance, Polymorphism, Encapsulation using Java**	**10**

	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	
	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6.0		**Exception Handling and Applets in Java**	**08**
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**52**

Suggested list of Experiments:

Note: *Before performing practical necessary Theory will be taught by concern faculty*

Sr.No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as “Pass” else “Fail””
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Textbooks:

1. Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education.
2. Yashwant Kanitkar, “Let Us Java”, 2nd Edition, BPB Publications.
3. D.T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition: 2015
4. Deitel, “C++ How to Program”, 4th Edition, Pearson Education.

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010.

Skill-Enhancement:

1. The students should be trained to code in Eclipse (an industry accepted software tool). Also, for a given problem statement, there is need to include external library files (other than JDK files). Moreover, the students need to be trained on Maven (a build tool).
2. Real-life mini-problem statements from software companies (coming in for placement) to be delegated to groups of 3-4 students each and each group to work on the solution for 8-12 hours (last 2 lab sessions).

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Term Work:

At least **12** experiments (**06 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.
The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam should cover all **12** experiments for examination.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1A, in case it is half-year project.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	04$	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Pre-requisite:

1. FEC105 - BEE

Course Objectives:

1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems
2. To familiarize the students with the designing and making of Printed circuit boards(PCB)
3. To improve the knowledge of electronics hardware among students

Course outcomes:

After successful completion of the course student will be able to:

1. Create the electronics circuit for particular application/experiment.
2. Design and simulate the circuits by putting together the analog and digital components
3. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
4. Realize the PCB design process and gain up-to-date knowledge of PCB design software.
5. Utilize the basic electronic tools and equipment's (like DMM, CRO, DSO etc.)
6. Analysis of hardware fault (Fault detection and correction)

Module No.	Unit No.	Topics	Hrs.
1.0		**Identification and Designing of Circuit**	**08**
	1.1	Identification of particular application with understanding of its detail operation. Study of necessary components and devices required to implement the application.	
	1.2	Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc)	
2.0		**Software simulation and Implementation on GPP**	**12**
	2.1	Simulation of circuit for particular application using software's to verify the expected results	
	2.2	Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
3.0		**PCB design and optimization**	**08**
	3.1	Design the circuit by placing components using PCB design software's.	
	3.2	Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material	
4.0		**Implementation of PCB**	**08**
	4.1	Transfer the designed PCB on Copper clad either by using dark room or taking printout on glossy paper, etc (use available suitable method).	
	4.2	Perform Etching and then Soldering.	
5.0		**Detection of Hardware faults and Result verification**	**08**
	5.1	Identify the hardware faults in designed circuit and subsequently rectify it	
	5.2	Now again verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
6.0		**Understanding the Troubleshooting**	**08**
	6.1	Understand the trouble shooting by removing some wired connection.	
	6.2	Understand the trouble shooting of track. Troubleshoot the faculty components or devices	
		Total	**52**

NOTE: During 1st week or within 1-month of the beginning of the semester, following topics related to ADC and DAC should be covered as theoretical concepts.

a. **Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.**

b. **Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.**

Reference books:

1. Schultz Mitchel E., *"Grob's Basic Electronics",* McGraw-Hill Education; 10th edition, 25 October , 2006.
2. Charles Platt, *"Make Electronics: Learning by discovery",* O'Reilly; 2nd edition, 18 September , 2015.
3. Forrest M Mims III, *"Getting started in Electronics",* Book Renter, Inc.; 3rd edition , 1 January 2000.

4. R S Khandpur, "*Printed circuit board*", McGraw-Hill Education; 1st edition, 24 February , 2005.
5. Kraig Mitzner, "*Complete PCB Design Using OrCAD Capture and PCB Editor",* Academic Press; 2nd edition , 20 June 2019.

Suggested Software tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html#
2. Eagle : https://www.autodesk.in/products/eagle/overview
3. OrCAD: https://www.orcad.com/
4. Multisim : https://www.multisim.com/
5. Webbench:http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html
6. Tinkercad : https://www.tinkercad.com/

Online Repository:

1. https://www.electronicsforu.com
2. https://circuitdigest.com
3. https://www.electronicshub.org

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC401	Engineering Mathematics-IV	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg. of Test 1 & 2					
ECC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. ECC301-Engineering Mathematics-III & Binomial Distribution.

Course Objectives: The course is aimed:

1. To understand line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To understand probability distributions and expectations.
4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To understand the concepts of Quadratic forms and Singular value decomposition.
6. To understand the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module	Detailed Contents	Hrs.
01	**Module: Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations ,Z- Transform.	7
02	**Module: Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Module: Probability Distributions** 1.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Module: Linear Algebra: Vector Spaces:-** 4.1 Vectors in n-dimensional vector space, norm, dot product, The CauchySchwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence and Independence, QR decomposition.	6
05	**Module: Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7

06	**Module: Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-** Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action , Several dependent variables.	6
Total		39

References:

1.Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2.Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5 Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
8.Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work (25-Marks):

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment Test (25-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Micro-controllers	3	-	--	3	-	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC402	Micro-controllers	20	20	20	80	03	-	-	100

Course Pre-requisites:

1. ECC303 - Digital System Design

Course objectives:

1. To develop background knowledge of Computer and its memory System.
2. To understand architecture of 8051 and ARM7 core.
3. To write programs for 8051 microcontrollers.
4. To understand design of Microcontroller Applications.

Course outcomes:

After successful completion of the course student will be able to:

1. Understand Computer and its memory System,
2. Understand the detailed architecture of 8051 and ARM7 Core.
3. Write programs for 8051 microcontrollers.
4. Design an applications using microcontroller.

Module No.	Unit No.	Topics	Hrs
1		**Overview of Microprocessor based System**	5
	1.1	Overview of microcomputer systems and their building blocks, Memory Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory	
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access	
	1.3	Concept of RISC & CISC Architecture	
	1.4	Harvard & Von Neumann Architecture	
2		**The Memory Systems**	4
	2.1	Classification of Memory : Primary and Secondary	
	2.2	Types of Semiconductor memories	
	2.3	Cache Memory	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)	
3		**8051 Microcontroller**	8
	3.1	Comparison between Microprocessor and Microcontroller	
	3.2	Features, architecture and pin configuration	
	3.3	CPU timing and machine cycle	
	3.4	Input / Output ports	
	3.5	Memory organization	
	3.6	Counters and timers	
	3.7	Interrupts	
	3.8	Serial data input and output	
4		**8051 Assembly Language Programming and Interfacing**	9
	4.1	Addressing modes	
	4.2	Instruction set	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts	
	4.5	Interfacing with LEDs, Relay and Keys	
5		**ARM7**	8
	5.1	Introduction & Features of ARM 7	
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M	
	5.3	Architectural inheritance, Pipelining	
	5.4	Programmer’s model	
	5.5	Brief introduction to exceptions and interrupts handling	
	5.6	Instruction set: Data processing, Data Transfer, Control flow	
6		**Study 8 bit microcontroller Applications**	5
	6.1	Understanding features of NXP 89v51RD2, Atmega 328P and PIC16F886	
	6.2	Selecting a microcontroller for an application	
	6.3	Study of 89v51 based Clock Using I2C RTC and Seven Segment Display	
	6.4	PIC16F886 Speed Control of DC Motor.	
	6.5	Atmega 328P based remote temperature monitoring with LCD display	
		Total	39

Text Books:

1. Douglas V Hall, SSSP Rao “Microprocessors & Interfacing”, McGraw Hill
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill
3. Shibu K. V “Introduction to embedded systems” McGraw Hill.
4. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, “The 8051 Microcontroller & Embedded systems”, Pearson Publications, Second Edition 2006.
5. C. Kenneth J. Ayala and D. V. Gadre, “The 8051 Microcontroller & Embedded system using assembly & ‘C’ ”, Cengage Learning, Edition 2010.
6. Steve Furber, “ARM System on chip Architecture”, Pearson,2nd edition.

Reference books:

1. “MCS@51 Microcontroller, Family User’s Manual” Intel
2. “PIC16F882/883/884/886/887 Data Sheet”, Microchip.
3. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
4. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips
5. James A. Langbridge, “Professional Embedded Arm Development”, Wrox, John Wiley Brand& Sons Inc., Edition 2014

NPTEL/ Swayam Course:

1. Course: Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur); **https://swayam.gov.in/nd1_noc20_ee42/preview**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs)	Term Work	Prac. and Oral	Total
		Internal assessment			End Sem. Exam. (ESE)				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. ECC302-Electronic Devices & Circuits

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

After successful completion of the course student will be able to:

1. Outline and classify all types of integrated circuits.
2. Understand the fundamentals and areas of applications for the integrated circuits.
3. Develop the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical & practical results in integrated circuits.
5. Identify the appropriate integrated circuit modules for designing engineering application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Operational Amplifier**	**07**
	1.1	Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	
	1.2	Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.	
	1.3	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp.	
2.0		**Linear Applications of Operational Amplifier**	**08**
	2.1	Voltage to current and current to voltage converter.	
	2.2	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters.	
	2.3	Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3.0		**Non-Linear Applications of Operational Amplifier**	**07**
3.0	**3.1**	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector.	
4.0		**Timer IC 555 and it's applications**	**07**
	4.1	Functional block diagram and working of IC 555	
	4.2	Design of Astable and Monostable multivibrator using IC 555	
	4.3	Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator.	
5.0		**Voltage Regulators.**	**06**
	5.1	Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series).	
	5.2	Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC).	
	5.3	Introduction and block diagram of switching regulator, Introduction of LM 317.	
6.0		**Special Purpose Integrated Circuits**	**04**
	6.1	Functional block diagram and working of VCO IC 566 and application as frequency modulator.	
	6.2	Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	
		Total	**39**

Textbooks:

1. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.
2. D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.

Reference Books:

1. K. R. Botkar, “Integrated Circuits”, Khanna Publishers (2004)
2. Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, Tata McGraw Hill, 3rd Edition.
3. David A. Bell, “Operation Amplifiers and Linear Integrated Circuits”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “Operation Amplifiers and Linear Integrated Circuits”, Prentice Hall, 6th Edition.
5. J. Millman, Christos CHalkias, and Satyabratatajit, Millman’s,“Electronic Devices and Circuits,” McGrawHill, 3rdEdition.

NPTEL/ Swayam Course:

1. Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore);
   https://swayam.gov.in/nd1_noc20_ee13/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ECC404	Signals and Systems	20	20	20	80	03	25	--	125

Course pre-requisite:

1. ECC301 – Engineering Mathematics III

Course objectives:

1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

Course outcomes:

After successful completion of the course student will be able to:

1. Classify and Analyze different types of signals and systems
2. Analyze continuous time LTI signals and systems in transform domain
3. Analyze and realize discrete time LTI signals and systems in transform domain
4. Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5. Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to signals and systems**	**07**
	1.1	**Introduction to Signals:** Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. **Classification of Signals:** analog and discrete time signals, even and odd signals, periodic and non-periodic signals , deterministic and non-deterministic signals, energy and power signals.	
	1.2	**Systems and Classification of systems:** System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.	
2.0		**Time domain analysis of Continuous Time and Discrete Time systems**	**07**
	2.1	**Linear Time Invariant (LTI) systems:** Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.	
	2.3	Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.	
3.0		**Fourier Analysis of Continuous and Discrete Time Signals and Systems**	**07**
	3.1	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform, Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	
4.0		**Laplace Transform and Continuous time LTI systems**	**06**
	4.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	
	4.2	**Analysis of continuous time LTI systems using Laplace Transform: C**ausality and stability of systems in *s*-domain, Total response of a system.	
5.0		***z*-Transform and Discrete time LTI systems**	**08**
	5.1	Need of *z*-Transform, *z*-Transform of finite and infinite duration sequences, Concept of Region of Convergence, *z*-Transform	

		properties, Standard *z*-transform pairs, relation between *z*-transform and discrete time Fourier Transform, one sided *z*-Transform. Inverse *z*-Transform: Partial Fraction method only.	
	5.2	**Analysis of discrete time LTI systems using *z*-Transform**: Systems characterized by Linear constant coefficient difference equation, Transfer Function, plotting Poles and Zeros of a transfer function , causality and stability of systems, Total response of a system.	
6.0		**FIR and IIR systems**	**04**
	6.1	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems.	
	6.2	**Realization structures of LTI system:** Direct form –I and direct form II, Linear Phase FIR structures.	
Total			**39**

Text books:

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Reference books:

1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
2) Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.
3) V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
5) Luis F. Chaparro, Signals and Systems Using MATLAB, Academic Press
6) Rangaraj M. Rangayyan, “Biomedical Signal Analysis- A Case Study Approach”, Wiley 2002.
7) Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

NPTEL/ Swayam Course:

1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview

Teachers and students are encouraged to use *Signals and Systems Laboratory: Virtual Laboratory* (Reference number 8) for demonstration of concepts such as systems and their properties, Fourier analysis etc.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 06 Tutorials covering entire syllabus and 01 course project must be given during the “Class Wise Tutorial”.

Students can form team of maximum 4 members and work on course project using any software viz. C, Python, Scilab, Matlab, Octave, etc. The course project should be appropriately selected in order to demonstrate any concept learnt in this course.

03-hours (out of the total 12-hours allotted for the tutorials) can be utilized for the course project completion.

Term work assessment must be based on the overall performance of the student with every tutorial and a course project graded from time to time. The grades will be converted to marks as per “Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Prac. & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC301 - Engineering Mathematics- III
2. ECC302 - Electronic Devices and Circuits

Course Objectives:

1. To illustrate the fundamentals of basic communication system.
2. To understand various analog modulation and demodulation techniques.
3. To focus on applications of analog modulation and demodulation techniques.
4. To explain the key concepts of analog and digital pulse modulation and demodulation techniques.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand the basic components and types of noises in communication system.
2. Analyze the concepts of amplitude modulation and demodulation.
3. Analyze the concepts of angle modulation and demodulation.
4. Compare the performance of AM and FM receivers.
5. Describe analog and digital pulse modulation techniques.
6. Illustrate the principles of multiplexing and demultiplexing techniques.

Module No.	Unit No.	Topics	Hours
1		**Basics of Communication System**	**05**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation.	**03**
	1.2	Types of noise, signal to noise ratio, noise figure, noise temperature and Friss formula.	**02**
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations.	**04**
	2.2	DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems.	**04**
	2.3	Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	**04**
3		**Angle Modulation and Demodulation**	**10**
	3.1	Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrowband FM and wideband FM.	**04**
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre- emphasis and de-emphasis	**03**
	3.3	FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, amplitude limiting and thresholding, Applications of FM and PM.	**03**
4		**Radio Receivers**	**04**
	4.1	Characteristics of radio receivers, TRF, Super - heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Communication receiver.	**03**
	4.2	FM receiver block diagram, comparison with AM receiver.	**01**
5		**Analog and Digital Pulse Modulation & Demodulation**	**06**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect.	**03**
	5.2	PAM, PWM, PPM generation, detection and applications. Basics of PCM system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM).	**03**
6		**Multiplexing & De-multiplexing**	**02**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications.	**02**
		Total	**39**

Textbooks:

1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition.
4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011.
5. Louis Frenzel, "Communication Electronics", Tata McGraw Hill, Third Edition.

NPTEL/ Swayam Course:

1. Course: Analog Communication By Prof. Goutam Das (IIT Kharagpur);
https://swayam.gov.in/nd1_noc20_ee69/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL401	Micro-controllers Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL401	Micro-controllers Lab	-	-	-	-	-	25	--	25

Course Objectives:

1. To understand development tools of microcontroller based systems.
2. To learn programming for different microcontroller operation & interface to I/O devices.
3. To develop microcontroller based applications.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand different development tools required to develop microcontroller based systems.
2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations.
3. Write assembly language programs for general purpose I/O, Timers & Interrupts.
4. Interface & write programs for Input and Output devices
5. Develop microcontroller based Applications.

Suggested Experiment List:

1. Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing)
2. Code Conversion
3. Transfer of data bytes between Internal and External Memory
4. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
5. Interfacing of Matrix Key board, LED, 7 Segment display, LCD, Stepper Motor, UART

At Least 10 experiment Minimum two from each category of above list must be given during the **Laboratory session batch wise**. Computation/simulation based experiments are also encouraged.

Before starting the experiments there should be one session on Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.

Mini project based on 8051 derivatives, PIC, AVR & other 8 bit microcontrollers using Assembly and/or C language. (Readymade of Arduino & raspberry pi are **not recommended here**)

Note: Mini Project can be considered as a part of term-work.

Term Work (25-Marks):

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL402	Linear Integrated Circuits Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Lab.	--	--	--	--	--	25	25	50

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the differences between theoretical, practical and simulated results in integrated circuits.
2. Apply the knowledge to do simple mathematical operations.
3. Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.

Laboratory Plan:

Minimum 8 hardware practical (compulsorily based on IC 741, IC 555, IC 723 and remaining on VCO 566 or PLL 565) and 2 simulations should be conducted. At least one experiment from each Module of syllabus.

Suggested list of experiments:

1. Design inverting, non-inverting amplifier and buffer using IC 741.
2. Design summing and difference amplifier using op-amp.
3. Design voltage to current converter with grounded load.
4. Design and analyze Integrator
5. Design and analyze Differentiator
6. Design Schmitt trigger using Op-amp.
7. Design Wein bridge and RC phase shift Oscillator.
8. Design and analyze second order High pass and Low pass filter
9. Design and analyze Band pass and Band reject filter.
10. Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.
11. Design Monostable Multivibrator using IC 555.
12. Design Low voltage Low current voltage regulator using IC 723.
13. Design High voltage High current voltage regulator using IC 723.
14. Design Frequency Modulator using IC 566
15. Design FSK Demodulator using IC 565
16. Design Instrumentation amplifier using 3 Op-Amp.
17. Design Precision rectifier
18. Design Square & Triangular wave generator

Term Work (25-Marks):

At least 10 Experiments including 02 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Principles of Communication Engineering Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Lab.	--	--	--	--	--	25	25	50

Course Pre-requisites:

1. Usage of basic Electronic instruments and components.
2. Fundamentals of Electronic Devices and circuits

Course Objectives:

1. To give an understanding of Time and Frequency domain representation of signals.
2. To demonstrate continuous wave modulation and demodulation.
3. To demonstrate analog and digital pulse communication.
4. Able to use simulation software to build communication circuits.

Course Outcomes:

After successful performance of the practicals student will be able to:

1. Analyze analog modulation techniques.
2. Analyze the waveforms of Radio receivers.
3. Implement analog pulse modulation and demodulation circuits.
4. Demonstrate digital pulse modulation and demodulation techniques.
5. Verify the concepts of TDM and FDM.

Suggested list of Experiments:

Sr. No	Title
1	Generation of AM modulation and demodulation.
2	Analyze waveforms at various stages of SSB system.
3	Generation of FM modulation and demodulation.
4	Analyze the output waveforms of each block of AM transmitter /receiver
5	Analyze the output waveforms of each block of FM transmitter /receiver
6	Design and implement Pre-emphasis and De-emphasis circuit.
7	Verification of sampling theorem.
8	Generation of PAM modulation and demodulation.
9	Generation of PWM and PPM modulation and demodulation.
10	Demonstrate Digital pulse transmission technique (PCM)
11	Demonstrate Digital pulse transmission technique (DM,ADM)
12	Observation of TDM multiplexing and de-multiplexing signals.
13	Observation of FDM multiplexing and de-multiplexing signals.

Term Work (25-Marks):

At least **10** experiments (**07 hardware experiments and at least 03 software experiments**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and application oriented. Signal should be analyzed in time and frequency domain.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "**Credit and Grading System**" manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 10 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL404	Skill Lab: Python Programming	-	04	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL404	Skill Lab: Python Programming	-	-	-	-	25	25	50

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course pre-requisite:

1. ECL304 – Skill Lab: C++ and Java Programming.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Python**	6
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements	
2.0		**Functions and File I/O Handling**	8
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, *with* keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3.0		**Object Oriented Programming**	9
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4.0		**Graphical User Interface and Image processing**	9
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5.0		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6.0		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor,	
	6.5	Support Vector Machines	
		Total	**52**

Text Books:

1. Yashavant Kanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1 edition (8 July 2019).
2. Dusty Phillips, “Python 3 object-oriented Programming”, Second Edition PACKT Publisher August 2015.
3. John Grayson, “Python and Tkinter Programming”, Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python , E Balagurusamy, McGraw Hill Education.
7. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code”, Addison Wesley; 3 edition (1 October 2013).

Reference Books:

1. Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, “Head First Python” O′Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O′Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: https://www.python.org/downloads/
2. Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation : https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

The following list of experiments and course project is for illustration purpose. Faculty members are required to introduce their own innovative list of experiments based on above curriculum.

Sr. No.	Problem Statement	Module No.
1.	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures.	Module 1

	4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set s = {10, 2, -3, 4, 5, 88} a. Number of items in sets s b. Maximum element in sets s c. Minimum element in sets s d. Sum of all elements in sets s e. Obtain a new sorted set from s, set s remaining unchanged f. Report whether 100 is an element of sets s g. Report whether -3 is not an element of sets s.	
2.	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. Generate and print a list of tuples containing name, age and salary from the 3lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3.	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	Module 3
4.	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain individual histograms. 4.Write Python program for histogram equalization 5 Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5.	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a. Find and print the name of the country with the highest GDP b. Find and print the name of the country with the lowest GDP c. Print text and input values iteratively	Module 5

	d. Print the entire list of the countries with their GDPs e. Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a. a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6.	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server. 7. Write Python Program to study image morphological operations.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

1. Use of free cloud service such as Google Colab to run python scripts is encouraged.

2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Term Work (25-Marks):

At least **12 experiments and 01 course project** should be performed. Term work assessment must be based on the overall performance of the student with every experiment and project graded from time-to-time. The grades will be converted to marks as per "**Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini Project 1B	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM401	Mini Project 1B	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1B, in case it is half-year project.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	04[$]	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	-	-	-	25	25	50

$ indicates work load of Learner (Not Faculty), for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course pre-requisite:

1. ECM301 – Mini-Project 1A
2. ECL304 – C++ and Java Programming
3. ECC302 – Electronic Devices and Circuit

Course Objectives:

1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board, Raspberry Pi, Arduino IDE (Integrated Development Environment) and Python programming.
2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board.
3. To increase students critical thinking ability and provide solutions to some real time problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources.
2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
3. Design Arduino based projects for a given problem.
4. Write code using python language using IDE for utilizing the onboard resources.
5. Apply the knowledge of interfacing different devices to raspberry Pi board to accomplish a given task.
6. Design Raspberry Pi based projects for a given problem.

Experiment No.	Unit No.	Section A: Arduino Board	Hrs.
EX.1.0		**Introduction to Arduino Board**	**02**
	1.1	**Introduction to Arduino Uno board and integrated development environment (IDE**	
	1	**Write the code for blinking the on board led with a specified delay** Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.	
EX.2.0		**GPIO (along with Analog pin) Programming**	**04**
	2.1	**Introduction to programming GPIO, Analog and PWM PINS.**	
	1	**Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.**	
	2	**Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.**	
	3.	**Generate varying duty cycle PWM using Arduino.**	
EX.3.0		**Controlling output devices/Displaying**	**04**
	3.1	**Introduction to different sensor (Analog and Digital), Relays, Motors and display.**	
	1	**Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.**	
	2	**Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device**	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.**	
5.0		**Sample Projects**	**10**
	1.	**Waste Management System**	
	2.	**Smart City Solutions**	
	3.	**Energy Monitoring Systems**	
	4.	**Smart Classrooms and learning Solutions**	
	5.	**Home security systems**	
	6.	**Smart Agriculture solutions**	
	7.	**Healthcare solutions.**	
	8.	**Industrial Applications**	
	9.	**IoT Applications**	
	10.	**Robotics**	
		Section 'A' Total Hrs.	**24**

Experiment No.	Unit No.	Section B: Raspberry Pi	Hrs.
EX.1.0		**Introduction to Raspberry PI**	**02**
	1.1	**What is Raspberry PI? Downloading and Installation of NOOBS, First Power-Up & Having a Look around, Introduction to the Shell and Staying updated.**	
	1	**Familiarization with Raspberry PI and perform necessary software installation.** Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	

EX.2.0		**Interfacing with Input / Output Devices using Python**	**04**
	2.1	**Introduction to Python, Connecting to the outside World with GPIO.**	
	1	**To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.	
	2	**To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).	
	3.	**To interface analog sensor using MCP 3008 analog to digital converter chip.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	
EX.3.0		**Interfacing Temperature Sensor, Motors, Display Devices.**	**04**
	3.1	**Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.**	
	1	**To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor.	
	2	**To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.	
	3	**To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing)** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.	
	2	**Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI**	
	3	**Write a program on Raspberry PI to upload temperature and humidity data from thingspeak cloud.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	
EX.5.0		**Understanding of Communication Protocols**	**04**
	5.1	**Introduction to MQTT, IFTTT protocols and configuration steps.**	
	1	**Write a program on Raspberry PI to publish temperature data to MQTT broker**	
	2	**Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.**	
	3	**Configuration of Webserver using Raspberry PI.**	
6.0		**Sample Projects**	**10**
	1.	**MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud**	
	2.	**License Plate Recognition using Raspberry Pi and OpenCV**	
	3.	**Real Time Face Recognition with Raspberry Pi and OpenCV**	
	4.	**Smart Garage Door Opener using Raspberry Pi**	

	5.	**Remote Controlled Car Using Raspberry Pi and Bluetooth**	
	6.	**Fingerprint Sensor based door locking system using Raspberry Pi**	
	7.	**Raspberry Pi Ball Tracking Robot using Processing**	
	8.	**Web Controlled Home Automation using Raspberry Pi**	
	9.	**Line Follower Robot using Raspberry Pi**	
	10.	**Raspberry Pi based Smart Phone Controlled Home Automation**	
	11.	**Web Controlled Raspberry Pi Surveillance Robotic Car**	
	12.	**Raspberry Pi Based Weight Sensing Automatic Gate**	
	13.	**Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector**	
	14.	**Detecting Colors using Raspberry Pi and Color Sensor TCS3200**	
	15.	**Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor**	
	16.	**Call and Text using Raspberry Pi and GSM Module**	
	17.	**Raspberry Pi Home Security System with Email Alert**	
	18.	**Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor**	
	19.	**Web Controlled Notice Board using Raspberry Pi**	
	20.	**RF Remote Controlled LEDs Using Raspberry Pi**	
	21.	**RFID and Raspberry Pi Based Attendance System**	
	22.	**Raspberry Pi Interactive Led-Mirror**	
	23.	**Garage Door monitor using Raspberry Pi**	
	24.	**Raspberry Pi Digital Code Lock on Breadboard**	
	25.	**Electronic Voting Machine using Raspberry Pi**	
		Section 'B' Total Hrs.	**28**
		Total A + B	**52**

Reference Books:

1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017)
2. Simon Monk, "Raspberry PI Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition
3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill
4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017)
5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)

Software Tools:

1. Raspbian OS: https://www.raspberrypi.org/downloads/
2. Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/
3. SD Card Formatter: https://www.sdcard.org/downloads/formatter/
4. Arduino IDE: https://www.arduino.cc/en/main/software

Online Repository:

1. GitHub
2. NPTEL Videos on Raspberry Pi and Arduino Programming
3. https://www.electronicsforu.com/raspberry-pi-projects
4. https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners
5. https://www.electronicshub.org/raspberry-pi-projects/

6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English
7. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: https://www.tinkercad.com/

AC- 5.05.2018
Item No. 4.53

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics and Telecommunication Engineering

Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.

2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.

3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.

4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar

Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

Program Structure for
B.E. Electronics & Telecommunication Engineering (Rev. 2016)
University of Mumbai (With Effect from 2017-2018)
Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC501	Microprocessor & Peripherals Interfacing	4	-	-	4	-	4
ECC502	Digital Communication	4	-	-	4	-	4
ECC503	Electromagnetic Engineering	4	-	1@	4	1	5
ECC504	Discrete Time Signal Processing	4	-	-	4	-	4
ECCDLO 501X	Department Level Optional Course I	4	-	-	4	-	4
ECL501	Microprocessor & Peripherals Interfacing Lab	-	2	-	-	1	1
ECL502	Digital Communication Lab	-	2	-	-	1	1
ECL503	Business Communication & Ethics Lab	-	2+2*	-	-	2	2
ECL504	Open Source Technology for Communication Lab	-	2	-	-	1	1
ECLDLO 501X	Department Level Optional Lab I	-	-	2#	-	1	1
Total		**20**	**10**	**3**	**20**	**7**	**27**

@ 1 hour to be taken as tutorial classwise #2 hours to be taken as either lab or tutorial based on subject requirement
*2 hours to be taken as tutorial batchwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC501	Microprocessor & Peripherals Interfacing	20	20	20	80	03	--	--	100
ECC502	Digital Communication	20	20	20	80	03	--	--	100
ECC503	Electromagnetic Engineering	20	20	20	80	03	25	--	125
ECC504	Discrete Time Signal Processing	20	20	20	80	03	--	--	100
ECCDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
ECL501	Microprocessor & Peripherals Interfacing Lab	--	--	--	--	--	25	25	50
ECL502	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL503	Business Communication & Ethics Lab	--	--	--	--	--	50	--	50
ECL504	Open Source Technology for Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 501X	Department Level Optional Lab I	--	--	--	--	--	25	--	25
Total				**100**	**400**		**175**	**75**	**750**

Course Code	Department Level Optional Course I
ECCDLO 5011	Microelectronics
ECCDLO 5012	TV & Video Engineering
ECCDLO 5013	Finite Automata Theory
ECCDLO 5014	Data Compression and Encryption

Course Code	Department Level Optional Course II
ECCDLO 6021	Digital VLSI Design
ECCDLO 6022	Radar Engineering
ECCDLO 6023	Database Management System
ECCDLO 6024	Audio Processing

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC501	Microprocessors & Peripherals	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC501	Microprocessors & Peripherals	20	20	20	80	--	--	--	100

Course prerequisite:

- Digital System Design

Course objectives:

- To understand the basic concepts of microcomputer systems.
- To develop background knowledge and core expertise in 8086 microprocessor and co-processor 8087.
- To write assembly language programs for 8086 microprocessor
- To understand peripheral devices and their interfacing to 8086 and to study the design aspects of basic microprocessor based system.

Course outcomes:

After successful completion of the course student will be able to

- Understand the basic concepts of microcomputer systems.
- Understand the architecture and software aspects of microprocessor 8086.
- Write Assembly language program in 8086.
- Know the Co-processor configurations.
- Interface peripherals for 8086.
- Design elementary aspect of microprocessor based system.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Microcomputer System**	**06**
	1.1	Block diagram of microprocessor based system: CPU, I/O Devices, Clock, Memory, Concept of Address, Data and Control Bus and Tristate logic.	
	1.2	Need of Assembly Language and its Comparison with higher level languages	
	1.3	Need of Assembler and Compiler and their comparison.	
2.0		**Architecture of 8086 Microprocessor**	**06**
	2.2	8086 Architecture and organization, pin configuration.	
	2.3	Minimum and Maximum modes of 8086.	
	2.4	Read and Write bus cycle of 8086.	
3.0		**Instruction set and programming of 8086**	**10**
	3.1	8086 Addressing modes.	
	3.2	8086 Instruction encoding formats and instruction set.	
	3.3	Assembler directives.	
	3.4	8086 programming and debugging of assembly language program. Programs related to: arithmetic, logical, delay, string manipulation, stack and subroutines, input, output, timer/counters.	
	3.5	Elementary DOS Programming: Introduction to int-21h services.	
4.0		**Peripherals interfacing with 8086 and applications.**	**10**
	4.1	8086-Interrupt structure.	
	4.2	Programmable peripheral Interface 8255.	
	4.3	Programmable interval Timer 8254.	
	4.4	Elementary features of 8259A and 8257 and interface.	
	4.5	Interfacing 8255, 8254 with 8086 and their applications	
5.0		**ADC, DAC interfacing with 8086 and its application**	**08**
	5.1	Analog to Digital Converter (ADC) 0809	
	5.2	Digital to Analog Converter (DAC) 0808	
	5.3	Interfacing ADC 0809, DAC 0808 with 8086 and their applications.	
	5.4	8086 based data Acquisition system.	
6.0		**8086 Microprocessor interfacing**	**08**
	6.1	8087 Math co-processor, its data types and interfacing with 8086.	
	6.2	Memory interfacing with 8086 microprocessor	
		Total	**48**

Text Books:

1. John Uffenbeck: "8086/8088 family: "Design, Programming and Interfacing", Prentice Hall, 2nd Edition
2. B. B. Brey: "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor", Pearson Pub, 8th Edition
3. Hall D.V: "Microprocessor and Interfacing Programming and Hardware", Tata McGraw Hill, 2nd Edition.
4. Yu-Cheng Liu/Glenn A. Gibson: "Microcomputer Systems: The 8086/8088 Family Architecture, Programming and Design", Phi Learning.

Reference Books:

1. Peter Abel: "IBM PC ASSEMBLY LANGUAGE & PROGRAMMING", Phi Learning.
2. A. K. Ray and K. M. Burchandi: "Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing", Tata McGrawHill, 3rd Edition
3. Don Anderson, Tom Shanley: "Pentium Processor System Architecture", MindShare Inc., 2nd Edition
4. National Semiconductor: Data Acquisition Linear Devices Data Book
5. Intel Peripheral Devices: Data Book.
6. The Intel 8086 family user manual.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Digital Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC502	Digital Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication

Course objectives:

- To identify the signals and functions of its different components,
- To learn about theoretical aspects of digital communication system and Draw signal space diagrams, compute spectra of modulated signals,
- To learn about error detection and correction to produce optimum receiver.

Course outcomes:

After successful completion of the course student will be able to

- Understand random variables and random processes of signal,
- Apply the concepts of Information Theory in source coding,
- Evaluate different methods to eliminate Inter-symbol interference,
- Compare different band-pass modulation techniques,
- Evaluate performance of different error control codes.

Module No.	Unit No.	Top	Hrs.
1.0		**Probability Theory & Random Variables and**	**08**
	1.1	Information, Probability, Conditional Probability of independent events, Relation between probability and probability Density , Raleigh Probability Density , CDF, PDF.	
	1.2	Random Variables, Variance of a Random Variable, correlation between Random Variables, Statistical Averages(Means),Mean and Variance of sum of Random variables, Linear mean square Estimation, Central limit theorem, Error function and Complementary error function Discrete and Continuous Variable, Gaussian PDF, Threshold Detection, Statistical Average, Chebyshev In-Equality, Auto-correction.	
	1.3	Random Processes	
2.0		**Information Theory and Source Coding**	**06**
	2.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and it's properties	
	2.2	Mini Source Coding, Shannon's Source Coding Theorem, Shannon-Fano Source Coding, Huffman Source Coding	
	2.3	Differential Entropy, joint and conditional entropy, mutual information and channel capacity, channel coding theorem, channel capacity theorem	
3.0		**Error Control Systems**	**12**
	3.1	Types of error control, error control codes, linear block codes, systematic linear block codes, generator matrix, parity check matrix, syndrome testing ,error correction, and decoder implementation	
	3.2	**Systematic and Non-systematic Cyclic codes**: encoding with shift register and error detection and correction	
	3.3	**Convolution Codes**: Time domain and transform domain approach, graphical representation, code tree, trellis, state diagram, decoding methods.	
4.0		**Bandpass Modulation & Demodulation**	**10**
	4.1	Band-pass digital transmitter and receiver model, digital modulation schemes	
	4.2	Generation, detection, signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK)Modulations, Binary Phase Shift Keying (BPSK) Modulation, Quaternary Phase Shift Keying QPSK), M- ary PSK Modulations, Quadrature Amplitude Modulation (QAM), Minimum Shift Keying (MSK)	

5.0		**Baseband Modulation & Transmission**	**04**
	5.1	Discrete PAM signals and it's power spectra	
	5.2	Inter-symbol interference, Nyquist criterion for zero ISI, sinusoidal roll-off filtering, correlative coding, equalizers, and eye pattern	
6.0		**Optimum Reception of Digital Signal**	**08**
	6.1	Baseband receiver	
	6.2	Probability of Error	
	6.3	Optimum Receiver and Filter	
	6.4	Matched Filter and its probability of error	
	6.5	Coherent Reception	
	Total		**48**

Text Books:

1. H. Taub, D. Schlling, and G. Saha, "Principles of Communication Systems," Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Lathi B P, and Ding Z., "Modern Digital and Analog Communication Systems," Oxford University Press, Fourth Edition, 2009.
3. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.

Reference Books:

1. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
3. P Ramakrishna Rao, "Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
4. M F Mesiya, "Contempory Communication systems", Mc-Graw Hill, Singapore, First Edition, 2013.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC503	Electromagnetic Engineering	04	--	@1	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC503	Electromagnetic Engineering	20	20	20	80	25	--	--	125

@ 1 hour to be taken as tutorial class wise

Course prerequisite:

- Vector Algebra and vector Calculus
- Various Co-ordinate system
- Two port network

Course objectives:

- To learn electromagnetics, including static and dynamic electromagnetic fields and waves within and at the boundaries of media.
- To learn mathematical skills, including Vectors and phasors and Partial differential equations.
- To learn Electromagnetic radiation and propagation in space and within transmission lines

Course outcomes:

After successful completion of the course student will be able to explain and evaluate EM fields and key physical parameters for:

- Fields and energies in simple planar, cylindrical, and spherical geometries, Fields within conducting and anisotropic media
- Electric and magnetic forces on charges, wires, and media Sinusoids and transients on TEM lines with mismatched impedances and tuning

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrostatics**	**07**
	1.1	Coulomb's Law & Electric Field Intensity, Electric Field due to point charge, line charge and surface charge distributions	
	1.2	Electric Flux Density, Gauss's Law and its Application to differential volume element, divergence, divergence theorem.	
	1.3	Electric potential, Relationship between Electric field & potential , Potential Gradient., electric dipole	
2.0		**Electric Fields in Material Space**	**06**
	2.1	Energy density in electrostatic field, Current and current Density, continuity equation, Polarization in dielectrics	
	2.2	Capacitance, capacitance of parallel plate; spherical; cylindrical capacitors with multiple di-electrics, Boundary conditions	
	2.3	Poisson's and Laplace's equation, General procedures for solving Poisson's and Laplace's equations.	
3.0		**Steady Magnetic Field**	**07**
	3.1	Biot-Savart's Law, Ampere's Circuital Law and its Applications, magnetic flux density, Magnetic Scalar and vectors potentials, Derivations of Biot-Savart's law and Ampere's law based on Magnetic Potential	
	3.2	Forces due to magnetic field, magnetic dipole, Classification of Magnetic Materials, Magnetic boundary conditions.	
4.0		**Maxwell's Equation and Electromagnetic Wave Propagation**	**12**
	4.1	Faraday's law, Displacement current, Maxwell's equations in point form and integral form, Boundary conditions for time varying field , magnetic vector potential, Time harmonic field, Introduction to the concept of Uniform Plane Wave and Helmholtz equation.	
	4.2	Wave Propagation in Free Space, Lossy and Lossless Dielectrics and in Good Conductors. Reflection of Plane Wave, Poynting Vector, Wave Power, Skin Effect, Wave Polarization and Standing Wave Ratio	
5.0		**Transmission Lines**	**10**
	5.1	Transmission line parameters, Transmission line equations, Input impedance, Standing wave ratio, Power, Transients on transmission lines.	
	5.2	Smith Chart, Applications of Smith Chart in finding VSWR ,and reflection coefficient, admittance calculations, impedance calculations over length of line.	

6.0		**Applications of Electromagnetics**	**06**
	6.1	Electrostatic discharge, Materials with high dielectric constant, Graphene, Inkjet printer, RF mems, Multidielectric systems, magnetic levitation, Memristor, Optical nanocircuits, Metamaterials, Microstrip lines and characterization of Data cables, RFID	
		Total	**48**

Text Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck - Tata McGraw-Hill Publishing Company Limited, Seventh Edition
2. Principles of Electromagnetics, Matthew N. O.Sadiku ,S.V.Kulkarni- Oxford university press, Sixth edition

Reference Books:

1. Electromagnetics with applications by J.D.Krauss and Daniel Fleisch fifth edition
2. Electromagnetic Field Theory Fundamentals, Bhag Singh Guru, Hüseyin R. Hiziroglu Cambridge University Press, Second Edition.
3. Electromagnetics, Joseph Edminister, , Mahmood Nahvi, Schaum Outline Series, Fourth edition.
4. R. K. Shevgaonkar, "Electromagnetic Waves" Tata McGraw Hil

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Discrete Time Signal Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC504	Discrete Time Signal Processing	20	20	20	80	--	--	--	100

Course prerequisite:

- Signals & Systems

Course objectives:

- To develop a thorough understanding of DFT and FFT and their applications.
- To teach the design techniques and performance analysis of digital filters
- To introduce the students to digital signal processors and its applications.

Course outcomes:

After successful completion of the course student will be able to

- Understand the concepts of discrete-time Fourier transform and fast Fourier transform.
- Apply the knowledge of design of IIR digital filters to meet arbitrary specifications.
- Apply the knowledge of design of FIR digital filters to meet arbitrary specifications.
- Analyze the effect of hardware limitations on performance of digital filters.
- Apply the knowledge of DSP processors for various applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Discrete Fourier Transform & Fast Fourier Transform**	**10**
	1.1	Definition and Properties of DFT, IDFT, Circular convolution of sequences using DFT and IDFT. Filtering of long data sequences: Overlap-Save and Overlap-Add Method for computation of DFT	
	1.2	Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT, and introduction to composite FFT.	
2.0		**IIR Digital Filters**	**10**
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band Stop and All Pass), Analog filter approximations: Butterworth, Chebyshev I, Elliptic.	
	2.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters (Butterworth and Chebyshev-I) from Analog filters with examples.	
	2.3	Analog and digital frequency transformations with design examples.	
3.0		**FIR Digital Filters**	**10**
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters. Frequency response, location of the zeros of linear phase FIR filters.	
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackmann, Kaiser), Design of FIR filters using Frequency Sampling technique, Comparison of IIR and FIR filters.	
4.0		**Finite Word Length effects in Digital Filters**	**06**
	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling.	
	4.2	Quantization in Floating Point realization of IIR digital filters, Finite word length effects in FIR digital filters.	
5.0		**DSP Processors**	**06**
	5.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator (MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism.	

	5.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware, Architecture of TMS320CX fixed and floating DSP processors.	
6.0		**Applications of Digital Signal Processing**	**06**
	6.1	Application of DSP for ECG signals analysis.	
	6.2	Application of DSP for Dual Tone Multi Frequency signal detection.	
	6.3	Application of DSP for Radar Signal Processing.	
		Total	**48**

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing"*, A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, " *Digital Signal Processing"*, Oxford University Press, 2015

Reference Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. Sanjit K. Mitra , Digital Signal Processing – A Computer Based Approach – 4th Edition McGraw Hill Education (India) Private Limited.
3. Oppenheim A., Schafer R., Buck J., "*Discrete Time Signal Processing*", 2nd Edition, Pearson Education.
4. B. Venkata Ramani and M. Bhaskar, "*Digital Signal Processors, Architecture, Programming and Applications*", Tata McGraw Hill, 2004.
5. L. R. Rabiner and B. Gold, "*Theory and Applications of Digital Signal Processi*ng", Prentice-Hall of India, 2006.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5011	Microelectronics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 5011	Microelectronics	20	20	20	80	--	--	--	100

Course prerequisite:

- Electronics Devices and Circuits- I
- Electronics Devices and Circuits- II

Course objectives:

- To understand integrated circuit biasing using MOSFET.
- To analyze single stage active load MOS amplifier.
- To analyze active load differential amplifier
- To understand implementation of passive components in ICs.

Course outcomes:

After successful completion of the course student will be able to

- Analyze various constant current source circuit using MOS
- Design and implement active load MOS amplifier.
- Design and implement active load differential amplifier

Module No.	Unit No.	Topics	Hrs.
1.0		**Basics of MOSFETs**	**08**
	1.1	Introduction to various fabrication process(in brief) Fabrication of NMOS and PMOS transistors along with mask layout diagram, Multi finger transistor, Scaling of MOSFET, Various Short channel effects in MOSFET, Second order effects in MOSFET, MOS as controlled resistor, MOS device capacitances	
2.0		**Integrated Circuit Biasing & Active Loads using MOSFET**	**08**
	2.1	Current Mirror, cascade current source, Wilson current source, bias independent current source using MOSFET,DC analysis and small signal analysis of MOS active load, DC analysis and small signal analysis of MOS advanced active load	
3.0		**Single Stage MOS Active Load amplifiers**	**08**
	3.1	CS amplifier with current source load, CS amplifier with diode connected load, CS amplifier with current source load, Common gate circuit, Cascode amplifier, Double Cascoding, Folded Cascode.	
4.0		**Active Load MOSFET Differential Amplifier**	**10**
	4.1	Basic MOS Differential Amplifier, DC transfer characteristics, small signal equivalent analysis, MOS differential amplifier with active load, MOS differential amplifier with cascode active load,	
5.0		**Passive Device Fabrication in IC**	**07**
	5.1	Fabrication of inductors, fabrication of transformers, fabrication of varactors, and fixed value capacitors.	
6.0		**Power Amplifiers**	**07**
	6.1	Class A, class B, Class C, Class D, Class E, Class F using MOSFET	
		Total	**48**

Text Books:

1. A. Sedra, K. Smith, adapted by A. Chanorkar "Microelectronic Circuits-Theory and Application *Advanced engineering mathematics*", Oxford Higher Education, 7th Edition
2. D. Neamen, "Electronic Circuits Analysis and Design", McGraw Hill Education, 3rd Edition
3. B. Razavi, "Design of Analog Integrated Circuits", McGraw Hill Education, Indian Edition

Reference Books:

1. B. Razavi,"R F Microelectronics", Pearson Publication, 2nd Edition

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5012	TV & Video Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 5012	TV & Video Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To understand basic concepts of TV system .
- To understand compression techniques
- To introduce to advanced systems and dvb standards

Course outcomes:

After successful completion of the course student will be able to

- Understand overview of TV system.
- Understand details of compression technique.
- Know about different dvb standards.
- Understand advanced digital systems

Module No.	Unit No.	Topics	Hrs.
1.0		**Fundamentals of TV system**	**10**
	1.1	Interlaced scanning, Composite video signal, VSB(Vestigial sideband transmission), Channel bandwidth, Study of transmitter and receiver block diagram of monochrome Television	
	1.2	Camera Tubes: Vidicon, Image Orthicon	
2.0		**Colour Television**	**10**
	2.1	Colour Fundamentals, Chromaticity diagram, Frequency interleaving, compatibility considerations	
	2.2	NTSC system characteristics, Encoder and Decoder block diagram, PAL system characteristics, Encoder and Decoder block diagram, Comparison of NTSC and PAL systems	
3.0		**Digital Video**	**08**
	3.1	Basics of digital video	
	3.2	Chroma subsampling:4:4:4,4:2:2,4:2:0,4:1:1 digital video formats	
	3.3	Video compression standards:MPEG2:DCT coding, codec structure. Introduction to H.264/MPEG-4 AVC, Introduction to H.265	
	3.4	Set-Top Box	
4.0		**Digital Video Broadcasting**	**06**
	4.1	Introduction to DVB-T,DVB-T2,DVB-H,DVB-S,DVB-C	
	4.2	Satellite Television	
5.0		**Advanced Digital TV Systems**	**10**
	5.1	MAC MACd2	
	5.2	HDTV,SUHDTV	
	5.3	Smart TV and its functions	
	5.4	Introduction to IPTV	
	5.5	Application of TV system as CCTV	
6.0		**Displays & Streaming Media Device**	**04**
	6.1	LCD,LED	
	6.2	Chromcast	
		Total	**48**

Text Books:

1. Monochrome and colour Television by R.R.Gulathi
2. Television and video engineering by A.M. Dhake

Reference Books:

1. Digital Television (Practical guide for Engineers) by Fischer

Websites:

1. https://www.dvb.org/resources/public/factsheets
2. https://en.wikipedia.org/wiki/Digital_Video_broadcasting

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5013	Finite Automata Theory	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 5013	Finite Automata Theory	20	20	20	80	--	--	--	100

Course prerequisite:

- Digital System Design

Course objectives:

This course provides in-depth knowledge of switching theory and the design techniques of digital circuits, which is the basis for design of any digital circuit. The main objectives are:

- To understand learn basic techniques for the design of digital circuits and fundamental concepts used in the design of digital systems.
- To design combinational logic circuits and its optimization and fault detection.
- To study Mealy and Moore synchronous and asynchronous sequential circuits design and their applications.

Course outcomes:

After successful completion of the course student will be able to

- Manipulate simple Boolean expressions using the theorems and postulates of Boolean algebra and to minimize combinational functions.
- Design and analyze small combinational circuits and to use standard combinational functions/ building blocks to build larger more complex circuits.
- Design and analyze small sequential circuits and devices and to use standard sequential functions/ building blocks to build larger more complex circuits.
- Design finite state machine understand the fundamentals and areas of applications for the integrated circuits.
- Perform symmetric and cascade threshold function and element

Module No.	Unit No.	Topics	Hrs.
1.0		**Combinational Logic**	**09**
	1.1	Notations of sets, Relations and Lattices, Venn diagram	
	1.2	Switching Algebra and functions, Boolean algebras and functions, Minimization of Boolean functions using map method and Tabulation Method, Prime implicant chart, Reduction of the chart, Branching method	
	1.3	Design of combinational Logic circuits, Contact networks, Functional decomposition and symmetric functions. Identification of symmetric functions	
2.0		**Threshold Logic & Synthesis of Threshold Networks**	**06**
	2.1	Threshold Logic, Threshold elements, Capabilities and limitations of threshold logic, elementary properties, Linear separability, Unate functions, Synthesis of threshold functions, Cascading of threshold elements.	
3.0		**Testing of Combinational Circuits**	**09**
	3.1	Reliable Design and fault Diagnosis, Fault Detection in combinational circuits, Fault location experiments, Fault Detection by Boolean Differences and path sensitization, Synthesis for testability, Multiple fault detection using map method, failure-Tolerant Design.	
4.0		**Sequential Circuits**	**12**
	4.1	Synchronous sequential circuits and iterative networks: Memory elements and their excitation functions; Synthesis of synchronous sequential circuits, Capabilities and limitations, State equivalence and Minimization, Minimization of completely specified and Incompletely specified sequential machines, Partition technique, Merger methods	
	4.2	Asynchronous sequential circuits: Hazards, Synthesis, State assignment and minimization	
	4.3	Finite state Machines – Mealy and Moore synchronous and asynchronous sequential circuits Design,	
5.0		**Structure and testing of Sequential Circuits**	**08**
	5.1	Structure of sequential Machines, Lattice of closed partitions, State Assignment using partitions, Reduction of output dependency, Input Independence and Autonomous clock.	
	5.2	Homing sequence, synchronizing sequence, Distinguishing sequence, Checking experiments, Machine identification, Recent Trends/Developments	

6.0		**Algorithmic State Machine**	**04**
	6.1	Introduction and components of ASM charts, Representation of sequential circuits using ASM charts, Example using ASM chart: 2 bit counter, binary multiplier, Weighing machine etc.	
		Total	**48**

Text Books:

1. Zvi Kohavi and Niraj K. Jha. "*Switching and Finite Automata Theory*", 3 Editions, Cambridge University Press.
2. Zvi Kohavi, *"Switching Theory and Finite Automata",* 2nd edition, Tata McGraw Hill
3. R. P. Jain, "*Switching Theory and Logic Design*", Tata McGraw Hill Education, 2003.
4. Lee Samuel C.," *Modern Switching Theory and Digital Design*", Prentice Hall PTR

Reference Books:

1. Morris Mano, "*Digital Logic and Computer Design*", Pearson Education
2. Samuel Lee, "*Digital Circuits and Logic design*", Prentice Hall.
3. William I. Fletcher, "*An Engineering Approach to Digital Design*", Prentice Hall.
4. John F. Wakerly, "*Digital Design ‐ Principles and Practices*", Pearson Education
5. A. Anand Kumar, *"Switching Theory and Logic Design",* PHI Learning private limited, 2014

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5014	Data Compression & Encryption	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 5014	Data Compression & Encryption	20	20	20	80	--	--	--	100

Course objectives:
To teach the students

- Lossless and Lossy compression techniques for different types of data.
- Data Encryption Techniques.
- Network and Web Security.

Course outcomes:
After successful completion of the course student will be able to

- Implement text, audio and video compression techniques.
- Understand Symmetric and Asymmetric Key Cryptography schemes.
- Understand network security.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Data Compression**	**12**
	1.1	Data Compression : Modelling and Coding, Statstical Modelling, Dictionary Schemes, LZ, Lossy Compression	
	1.2	Shannon – Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding	
	1.3	Difficulties in Huffman Coding, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW	
2.0		**Image Compression**	**06**
	2.1	DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards	
3.0		**Video and Audio Compression**	**08**
	3.1	Analog Video, Digital Video, MPEG – 2, H – 261 Encoder and Decoder	
	3.2	Sound, Digital Audio, μ-Law and A-Law Companding, MPEG – 1 Audio Layer (MP3 Audio Format)	
4.0		**Data Security**	**06**
	4.1	Security Goals, Cryptographic Attacks, Techniques	
	4.2	Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher	
	4.3	DES, AES	
5.0		**Number Theory and Asymmetric Key Cryptography**	**08**
	5.1	Prime Numbers, Fermat's and Euler's Theorem, Chinese Remainder Theorem, Discreet Logarithms	
	5.2	Principles of Public Key Crypto System, RSA	
	5.3	Key Management, Deffie-Hellman Key Exchange	
	5.4	Message Integrity, Message Authentication and Hash Functions, SHA, H MAC, Digital Signature Standards	
6.0		**Network Security**	**08**
	6.1	Email, PGP, S/MIME, Intrusion Detection System	
	6.2	Web Security Considerations, SSL Architecture, SSL Message Formats, TLS, Secure Electronic Transactions	
	6.3	Kerberos, X.509 Authentication Service, Public Key Infrastructure	
		Total	**48**

Text Books:

1. Mark Nelson, Jean-Loup Gailly,"The Data Compression Book", 2nd edition, BPB Publications
2. Khalid Sayood, "Introduction to Data Compression", 2nd Edition Morgan Kaufmann.
3. William Stallings, "Cryptography and Network Security Principles and Practices 5th Edition", Pearson Education.
4. Behrouz A. Forouzan, "Cryptography and Network Security", Tata McGraw-Hill.

Reference Books:

1. David Salomon, "Data Compression: The Complete Reference", Springer.
2. Matt Bishop, "Computer Security Art and Science", Addison-Wesley.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL501	Microprocessors & Peripherals Interfacing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL501	Microprocessors & Peripherals Interfacing Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

Experiments can be conducted on Assembler, Emulator or Hardware kits, in Assembly language.

- To write an assembly language program to perform 8-bit addition using multiple addressing modes, viz., direct, indirect, register, etc. addressing mode.
- To write an assembly language program to perform 16-bit Logical operations, viz., AND, OR, XOR, NAND, etc.
- To write an assembly language program to perform 32-bit Subtraction
- To write an assembly language program to generate 10 msec delay using software (register) and 8254
- To write an assembly language program to move 10 memory locations using String Instruction
- To write an assembly language subroutine (program) that takes a number as input and returns the square of it
- To write an assembly language program for interfaced 7 segment display or keypad or both, through 8255
- To write an assembly language program to read and save value from ADC
- To write an assembly language program to generate square / triangular / ramp waveforms using DAC
- To write an assembly language program for performing floating point division using 8087
- To write an assembly language program to use INT 21h DOS Functions, viz. read character, write character, get system date, etc

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL502	Digital Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL502	Digital Communication Laboratory	--	--	--	--	25	25	--	50

Experiments should be performed on Bread-board or on experimentation kits.

Suggested Experiment List

- To understand sampling theorem and reconstruction
- To understand Various line codes
- To observe the performance of Return to Zero (RZ) types of line code
- To observe the performance of Non- Return to Zero (NRZ) types of line code
- Modulation and Demodulation of Binary Amplitude Shift Keying
- Modulation and Demodulation of Binary Frequency Shift Keying
- Modulation and Demodulation of Binary Phase Shift Keying
- Modulation and Demodulation of Quadrature Phase Shift Keying
- To observe the effect of signal Distortion using EYE-Diagram
- To Study and perform Linear Block codes
- To Study and perform cyclic codes

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every

experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL503	Business Communication & Ethics Laboratory	2 (classwise)	2 (batch wise)	--	--	2	--	2

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL503	Business Communication & Ethics Laboratory	--	--	--	--	50	--	--	50

Course objectives:
To teach the students

- To inculcate professional and ethical attitude.
- To enhance effective communication and interpersonal skills.
- To build multidisciplinary approach towards all life tasks.

Course outcomes:
After successful completion of the course student will be able to

- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module No.	Unit No.	Topics	Hrs.
1.0		**Report Writing**	**05**
	1.1	Objectives of Report Writing	
	1.2	Language and Style in a report	
	1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
2.0		**Technical Writing**	**03**
	2.1	Technical Paper Writing (IEEE Format)	
	2.2	Proposal Writing	
3.0		**Introduction to Interpersonal Skills**	**09**
	3.1	Emotional Intelligence	
	3.2	Leadership and Motivation	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution and Negotiation Skills	
	3.6	Time Management	
	3.7	Decision Making	
4.0		**Meetings & Documentations**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice, Agenda and Minutes of a meeting	
	4.3	Business meeting etiquettes	
5.0		**Introduction to Corporate Ethics**	**02**
	5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
	5.2	Introduction to Intellectual Property Rights	
	5.3	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
6.0		**Employment Skills**	**07**
	6.1	Group Discussion	
	6.2	Resume Writing	
	6.3	Interview Skills	
	6.4	Presentation Skills	
	6.5	Statement of Purpose	
		Total	**28**

References

1. Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition
5. Heta Murphy, *"Effective Business Communication",* Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill.
8. Lehman, Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work:

Term work will consist of all assignments from the list. The distribution of marks for term

Work willl be as follows:

Book Report……..(10) Marks

Assignments …… (10) Marks

Project Report Presentation…….. (15) Marks

Group Discussion.…… (10) Marks

Attendance …… (05) Marks

TOTAL: ……(50) Marks

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL504	Open Source technology for Communication Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL504	Open Source technology for Communication Lab	--	--	--	--	25	25	--	50

Prerequisites:

- Principals of Communication Engineering
- Digital System Design
- Signals and Systems
- Electronics Circuits and Devices

Course objectives:

- Introduction to open source tools for communication lab.
- To simulate and analyze the various parameters of communication systems.
- To understand and implement the communication system/sub system.

Course outcomes:

After successful completion of the course student will be able to

- Learn open source programming tools for communication technology.
- Simulate and analyze the performance of communication system.
- Implement the communication system/subsystem.

Sample List of Experiments:

Note: These are few examples of experiments; teachers may prepare their own list.

Sr. No	Title	Resource
1	Installation of a. Python, NumPy and commPy or b. Octave or c. Scilab or d. Xilinx using HDL Or e. LT SPICE Or f. SEQUEL Note: Any one tool or a combination of tools .	See the E-resource Links
2	Write a program to represent analog signal to digital signal (A to D conversion)	http://www.scilab.in/files/textbooks/ProfSenthikumar/DC.pdf
3	Write a program to generate basic functions a. Unit Impulse Signal b. Unit Step Signal c. Generate Ramp Signal d. Exponential Sequence e. Generate Sine Sequence f. Cos Sequence	See the E-resource Links
4	Write a program to perform convolution and correlation on the given signal.	See the E-resource Links
5	Plot the ASK, FSK and PSk Waveforms using scilab/python	See the E-resource Links
6	Write a program to apply Low/High Pass Filter on the given signal.	See the E-resource Links
7	Write a program to read a speech signal and plot it and play it.	See the E-resource Links

8	Write a program to apply Low/High Pass Filter on the given signal.	See the E-resource Links
9	Write a code to design Butterworth/Chebyshev filter using Scilab/Octave/Python.	See the E-resource Links
10	Write a program to calculate Hamming distance using Scilab/python.	See the E-resource Links
11	Encoding and decoding of convolutional codes	1.https://github.com/veeresht/CommPy/blob/master/commpy/examples/conv_encode_decode.py 2.https://media.readthedocs.org/pdf/commpy/latest/commpy.pdf
12	Design and programming of of 1-bit Full adder and testing using Testbench.	See the E-resource Links
13	Design and programming of 4-bit adder using Full adder and testing using Testbench	See the E-resource Links
14	Design and programming of 8:1 Mux and testing using Testbench	See the E-resource Links
15	Design and programming of 3:8 Decoder and testing using Testbench	See the E-resource Links
16	Design and programming of D Latch and D Flip Flop and testing using Testbench	See the E-resource Links
17	Design and programming of T FF and testing using Testbench	See the E-resource Links
18	Design and programming of Counter and testing using Testbench	See the E-resource Links
19	Design and programming of RAM and testing using Testbench	See the E-resource Links
20	Design and Programming of FSM and testing using	See the E-resource Links

	Testbench	
21	Design and Simulation of Basic diode Circuits like Clipper, Clapper, Voltage Doubler using Sequel or LT Spice	See the E-resource Links
22	Design and simulation of single stage and Multistage BJT amplifier using Sequel or LT SPICE	See the E-resource Links
23	Design and simulation of Differential amplifier and current mirror circuit using Sequel or LT SPICE	See the E-resource Links
24	Design and Simulation of Basic Op-circuits like Inverting amplifier , Non-Inverting amplifier, Difference amplifier, I to V convertor, V to I Convertor etc using Sequel ot LT SPICE.	See the E-resource Links
25	Design and Simulation of oscillators and Filters using Op-amp using LT SPICE or Sequel.	See the E-resource Links
26	Simulation of non-linear applications of Op-amp like Schmitt Trigger, Window Detector, Precision Rectifier, Square Wave Generator etc using LT SPICE or Sequel.	See the E-resource Links

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Implementing liner block code of (7,4).
2. Implementing FSK TX and RX.
3. Implementing Nyquist criteria with noisy environment.

Suggested List of Mini Projects on Xilinx using HDL Programming

4. 16 bit Multiplier
5. 32 Bit CLA adder
6. Shift and Add Multiplier
7. GCD Calculator
8. 3-bit FIR Filter design
9. 4 Bit ALU
10. 4-bit Comparator
11. 2's Complement adder

Suggested List of Mini Projects using LT SPICE or SEQUEl

12. Audio Equalizer using Op-amp.
13. Strain Guage amplifier Circuit.
14. Synchronous DC-DC Buck Convertor.
15. RTD based 4 to 20mA transmitter circuit.

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

E-Resources:

1. Spoken Tutorial : http://spoken-tutorial.org/
2. Scilab: http://www.scilab.org/
3. Octave: https://www.gnu.org/software/octave/
4. Python: https://www.python.org/
5. Xilinx using HDL: **https://www.xilinx.com/products/design-tools/ise-design-suite/ise-webpack.html**
6. LT SPICE : http://www.linear.com/designtools/software/
7. SEQUEL**:** https://www.ee.iitb.ac.in/~sequel/

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.
Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5011	Microelectronics Laboratory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 5011	Microelectronics Laboratory	--	--	--	--	25	--	--	25

Term Work:

At least 08 tutorials covering entire syllabus must be given during the "**Tutorial session batch wise"**

Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5012	TV & Video Laboratory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 5012	TV & Video Laboratory	--	--	--	--	25	--	--	25

Suggested List of Experiments

- To study CVS
- Measurement of horizontal and vertical scanning frequency
- To study sound section of TV receiver
- To study receiver sections by using fault simulation switches
- To study DTH receiver
- To study HDTV
- To study set top box trainer
- To study LCD display
- To study LED display

Term Work:

At least 8 Practicals/ Tutorials covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5013	Finite Automata Theory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 5013	Finite Automata Theory	--	--	--	--	25	--	--	25

List of Mini Projects:

1. Combinational circuits
2. Synchronous sequential circuits (Finite state machine)
3. Asynchronous sequential circuits (Finite state machine)
4. Algorithmic state machine

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 8 Tutorials covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5014	Data Compression & Encryption	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 5014	Data Compression & Encryption	--	--	--	--	25	--	--	25

Suggested Practical List:

- Huffman Code.
- Adaptive Huffman Code.
- Arithmetic Code.
- LZW Compression and Decompression.
- Companding Implementation.
- Implementation of DCT.
- RSA and MD5 Algorithm.
- Packet Analyzer.
- PGP (Pretty Good Privacy).
- Vulnerability Scanner.
- Intrusion Detection System.
- Firewall.
- SSL

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful,

interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC601	Microcontrollers & Applications	4	-	--	4	--	4
ECC602	Computer Communication Networks	4	-	-	4	-	4
ECC603	Antenna & Radio Wave Propagation	4	-	-	4	-	4
ECC604	Image Processing and Machine Vision	4	-	--	4	--	4
ECCDLO 602X	Department Level Optional Course II	4	-	-	4	-	4
ECL601	Microcontroller & Applications Lab	-	2	-	-	1	1
ECL602	Computer Communication Network Lab	-	2	-	-	1	1
ECL603	Antenna & Radio Wave Propagation Lab	-	2	-	-	1	1
ECL604	Image Processing and Machine Vision Lab	-	2	-	-	1	1
ECLDLO 602X	Department Level Optional Lab II	-	2	-	-	1	1
Total		**20**	**10**	**-**	**20**	**5**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC601	Microcontroller& Applications	20	20	20	80	03	--	--	100
ECC602	Computer Communication Network	20	20	20	80	03	--	--	100
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	03	--	--	100
ECC604	Image Processing and Machine Vision Lab	20	20	20	80	03	--	--	100
ECCDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100
ECL601	Microcontroller & Applications Lab	--	--	--	--	--	25	25	50
ECL602	Computer Communication Network Lab	--	--	--	--	--	25	25	50
ECL603	Antenna & Radio Wave Propagation Lab	--	--	--	--	--	25	25	50
ECL604	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
ECLDLO 602X	Department Level Optional Lab II	--	--	--	--	--	25	--	25
Total				**100**	**400**		**125**	**100**	**725**

Course Code	Department Level Optional Course II
ECCDLO 6021	Digital VLSI Design
ECCDLO 6022	Radar Engineering
ECCDLO 6023	Database Management System
ECCDLO 6024	Audio Processing

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC601	Microcontrollers & Applications	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC601	Microcontrollers & Applications	20	20	20	80	--	--	--	100

Course objectives:

- To develop background knowledge and core expertise in microcontrollers.
- To understand peripheral devices and their interfacing to microcontrollers.
- To write programs for microcontrollers and their applications in Assembly and Embedded C Language.

Course outcomes:

After successful completion of the course student will be able to

- Understand the detailed architecture of 8051 and ARM7 microcontroller.
- Study the in-depth working of the microcontrollers and their Instruction set.
- Interface various peripheral devices to the microcontrollers.
- Write Assembly language and Embedded C program for microcontrollers.

Module No.	Unit No.	Topics	Hrs.
1.0		**8051 Microcontroller**	**12**
	1.1	Comparison between Microprocessor and Microcontroller	
	1.2	Features, architecture and pin configurations	
	1.3	CPU timing and machine cycle	
	1.4	Input / Output ports	
	1.5	Memory organization	
	1.6	Counters and timers	
	1.7	Interrupts	
	1.8	Serial data input and output	
2.0		**8051 Programming**	**08**
	2.1	Instruction set	
	2.2	Addressing mode	
	2.3	Assembler Directives	
	2.4	**Programs related to**: arithmetic, logical, delay, input, output, timer, counters, port, serial communication, and interrupts	
3.0		**8051 Interfacing and Applications**	**06**
	3.1	Interfacing of Display: LED, LCD and Seven Segment display	
	3.2	Stepper Motor and Relay	
	3.3	UART	
4.0		**ARM7: A 32 bit Microcontroller**	**08**
	4.1	The RISC and the CISC design philosophy	
	4.2	Concept of Cortex-A, the Cortex-R and the Cortex-M	
	4.3	Features of ARM Microcontroller	
	4.4	Pipeline Architecture	
	4.5	Registers	
	4.6	Exceptions, Interrupt and Vector Table	
	4.7	Memory Management	
5.0		**ARM7 Programming**	**08**
	5.1	Data Processing Instructions	
	5.2	Conditional and Branching Instructions	
	5.3	ARM-THUMB Interworking	
	5.4	Single-Register Load-Store Instructions	
	5.5	Stack Instructions	
	5.6	Software Interrupt Instructions	
6.0		**ARM Programming with Embedded C**	**06**
	6.1	General Purpose Input Output	
	6.2	Timer Mode	
	6.3	Pulse –Width Modulator Configuration	
		Total	**48**

Text Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "*The 8051 Microcontroller & Embedded systems*", Pearson Publications, Second Edition 2006.
2. C. Kenneth J. Ayala and D. V. Gadre, "*The 8051 Microcontroller & Embedded system using assembly & 'C*' ", Cengage Learning, Edition 2010.
3. Satish Shah, "*The 8051 Microcontrollers",* Oxford publication first edition 2010.
4. Andrew Sloss, Dominic Symes, and Chris Wright, "*ARM System Developer's Guide*" Morgan Kaufmann Publishers, First Edition 2004.
5. Lyla Das, "*Embedded Systems: An Integrated Approach*", Pearson Publication, First Edition 2013
6. James A. Langbridge, "*Professional Embedded Arm Development*", Wrox, John Wiley Brand& Sons Inc., Edition 2014

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Computer Communication Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC602	Computer Communication Networks	20	20	20	80	--	--	--	100

Course Pre requisite:

- Analog Communication

Course objectives:

- To introduce analysis and design of computer and communication networks.
- To design and configure a network for an organization. To implement client-server socket programs.
- To analyse the traffic flow and the contents of protocol frames.

Course outcomes:

After successful completion of the course student will be able to

- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer's specific needs.
- Perform basic configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications.
- Learn to simulate computer networks and analyse the simulation results.
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**06**
	1.1	Network Applications	
	1.2	Network Hardware	
	1.3	Network Software	
	1.4	Reference Models, overview of TCP/IP, layer Functions, services, sockets and ports, Encapsulation.	
2.0		**Introduction to Physical layer Services and System**	**08**
	2.1	Introduction to physical media, Coax, RJ 45 , fiber, twisted pair, DSL, HFC, WiMax, cellular, satellite, and telephone networks, bit transmission, frequency division multiplexing. time division multiplexing.	
3.0		**The Data Link Layer**	**08**
	3.1	Data link Layer Design Issues	
	3.2	Error Detection and Correction	
		Elementary Data Link Protocols, Sliding Window Protocols	
		Example Data Link Protocols: HDLC: High-Level Data Link Control, The Data Link Layer in The Internet.	
4.0		**The Medium Access Sub- Layer**	**06**
	4.1	Channel Allocation Problem.	
	4.2	Multiple Access Protocols.	
5.0		**The Network Layer**	**10**
	5.1	Network Layer Design Issues.	
	5.2	Routing Algorithms.	
	5.3	Congestion Control Algorithms, Quality of Service.	
	5.4	Internetworking.	
	5.5	The Network Layer In The Internet: The IP Protocol, IPv4 header, IP Addressesing, Subnetting.	
	5.6	Internet Control Protocols, The Interior Gateway Routing Protocol: OSPF, The Exterior Gateway Routing Protocol: BGP.	
6.0		**The Transport Layer**	**10**
	6.1	The Transport Service.	
	6.2	Elements of Transport Protocols.	
	6.3	The Internet Transport Protocol: UDP	
	6.4	The Internet Transport Protocol: TCP:-Introduction to TCP, The TCP Service Model, The TCP Protocol.	
	6.5	The TCP Segment Header.	
	6.6	TCP Connection Establishment, TCP Connection Release.	
	6.7	Modeling TCP Connection Management.	
	6.8	TCP Transmission Policy.	
	6.9	TCP Congestion Control.	
	6.10	TCP Timer Management, Transactional TCP.	

		Total	**48**

Text Books:

1. A. S. Tanenbaum,"Computer Networks", 4th edition, Prentice Hall
2. B. F. Ferouzan,"Data and Computer Communication", Tata McGraw Hill.

Reference Books:

1. Peterson & Davie, "Computer Networks", 2nd Edition, Morgan Kaufmann.
2. Kurose, Ross, "Computer Networking", Addison Wesley
3. S. Keshav, "An Engg, Approach To Computer Networking", Addison Wesley.
4. W. Richard Stevens, "TCP/IP Volume1, 2, 3", Addison Wesley.
5. D. E. Comer, "Computer Networks And Internets", Prentice Hall.
6. B. F. Ferouzan , "TCP/IP Protocol Suite", Tata McGraw Hill.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC603	Antenna & Radio Wave Propagation	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	--	--	--	100

Prerequisites:

- Electromagnetic Field
- Two port network
- Transmission Line

Course objectives:

- To learn fundamental parameters of Antenna
- To learn about linear wire antenna elements and Antenna arrays
- To learn about Special types of Antennas
- To learn about Antenna measurements and radio wave propagation

Course outcomes:

After successful completion of the course student will be able to

- Define Basic antenna parameters like radiation pattern, directivity and gain.
- Derive the field equations for the basic radiating elements like linear wire antenna and loop antenna.
- Design of uniform linear and planar antenna arrays using isotropic and directional Sources.
- Implement special types of Antennas like microstrip antennas and reflectors.

Module No.	Unit No.	Topics	Hrs.
1.0		**Antenna Fundamentals**	**08**
	1.1	Introduction, Radiation Mechanism, basic antenna parameters, Radiation pattern, radiation power density, radiation intensity, Beamwidth, directivity, Antenna efficiency, Gain, beam efficiency, bandwidth, polarization, input impedance, antenna vector effective length and equivalent areas, Antenna radiation efficiency, FRIIS transmission equation	
	1.2	Basic concepts of Maxwell's equation, vector potential, wave equation, near field and far field radiation, dual equations for electric and magnetic current sources.	
2.0		**Wire Elements: Dipoles, Monopoles, Loops and Helical**	**12**
	2.1	Infinitesimal dipole, radiation fields, radiation resistance, radiation sphere, near field, far field directivity, small dipole, finite length dipole, half wave length dipole, linear elements near or on infinite perfect conductors, Monopole antenna, Folded dipole. Design of dipole and monopole antenna	
	2.2	Loop Antenna: Small circular loop, comparison of small loop with short dipole, Ferrite loop, radiation patterns its parameters and their application.	
	2.3	Helical Antennas: Input impedance matching, Axial mode and normal mode propagation, Circular polarization using Helical Antenna	
3.0		**Arrays**	**12**
	3.1	Linear arrays, Array of two isotropic point sources, linear arrays of N elements, principle of pattern multiplication applicable to non-isotropic sources, Phase scanning arrays, broadside and End-fire Array, Increased Directivity end fire array, Calculations of Directivity, Beam width, Maxima and null directions for N-element Array.	
	3.2	Introduction to planner and circular arrays	
	3.3	Design of Yagi antenna and Log Periodic antenna	
4.0		**Aperture Antennas**	**06**
	4.1	Horn Antennas :E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn, Conical Horn	
	4.2	Reflector Antennas: Introduction, Plane Reflector, Corner Reflector, Parabolic Reflector, Design considerations	
5.0		**Patch Antenna**	**04**
	5.1	Microstrip antenna (MSA): Introduction, Feeding Techniques, Regular Shape MSAs (Rectangular, Circular, Equilateral Triangular), Design of Regular shape MSAs	
6.0		**Antenna Measurements & Wave Propagation**	**06**

	6.1	**Antenna Measurements:** Measurement of Antenna parameters: Input Impedance, Radiation Pattern, Gain (Two and Three antenna method), Polarization.	
	6.2	**Ground Wave Propagation:** Ground waves, effect of Earth's Curvature on Ground wave propagation, impact of imperfect earth	
	6.3	**Sky Wave Propagation** Ionosphere and Earth magnetic field effect, Critical frequency, Angle of incidence, Maximum usable frequency, Skip distance, Virtual height, Variations in ionosphere and Attenuation and fading of waves in ionosphere	
	6.4	Space Wave Propagation	
		Total	**48**

Text Books:

1. C. A. Balanis, Antenna Theory: Analysis and Design (3rd eds.), John Wiley & Sons, Hoboken, NJ, 2005.
2. J. D. Kraus, R. J. Marhefka, A.S. Khan "Antennas & Wave Propagation", McGraw Hill Publications, 4th Edition, 2011
3. G. Kumar, K. P. Ray, Broadband Microstrip Antenna, Artech House, 2002.

Reference Books:

1. Stutzman, Theile, " Antenna Theory and Design", John Wiley and Sons , 3rd Edition
2. R. E. Collin, "Antennas and Radio Wave Propagation", International Student Edition, McGraw Hill.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Image Processing & Machine Vision	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC604	Image Processing & Machine Vision	20	20	20	80	--	--	--	100

Prerequisites:

- Signals and Systems
- Discrete Time Signal Processing

Course objectives:

- To cover the fundamentals and mathematical models in digital image processing and Machine Vision
- To develop time and frequency domain techniques for image enhancement.
- To expose the students to classification techniques in Machine Vision
- To develop Applications using image processing and Machine Vision

Course outcomes:

After successful completion of the course student will be able to

- Understand theory and models in image processing.
- Interpret and analyze 2D signals in Spatial and frequency domain through image transforms.
- Apply quantitative models of image processing for segmentation and restoration for various applications.
- Find shape using various representation techniques and classify the object using different classification methods.

Module No.	Unit No.	Topics	Hrs.
1.0		**Digital Image Fundamentals**	**04**
	1.1	**Introduction** – Origin – Steps in Digital Image Processing , Components, Elements of Visual Perception – Image Sensing and Acquisition, Image Sampling and Quantization – Relationships between pixels, Transformation: Orthogonal, Euclidean, Affine	
	1.2	**Color Image Processing**: Color Fundamentals Color models.	
2.0		**Image Transforms**	**06**
	2.1	1-D DFT, 2-D Discrete Fourier Transform and Its Inverse, Some Properties of 2D DFT ,Walsh -Hadamard, Discrete Cosine Transform, Haar Transform	
3.0		**Image Enhancement**	**08**
	3.1	Image Negative, Log Transform, Power Law transform, Histogram equalization and Histogram Specification	
	3.2	**Spatial Domain**: Basics of Spatial Filtering, The Mechanics of Spatial Filtering, Generating Spatial Filter Masks–Smoothing and Sharpening Spatial Filtering	
	3.3	**Frequency Domain**:, The Basics of Filtering in the Frequency Domain, Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Laplacian, Unsharp Masking and Homomorphic filters	
4.0		**Morphological & Image Restoration**	**06**
	4.1	**Morphology**: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation.	
	4.2	**Restoration :**Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters	
5.0		**Patch Antenna**	**12**
	5.1	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, basic and advance edge detection, Edge linking and boundary detection , Canny's edge detection algorithm	
	5.2	**Thresholding** : Foundation, Role of illumination, Basic Global thresholding	
	5.3	**Region Based segmentation**: Region Growing, Region Splitting and merging	
	5.4	**Region Identification**, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences, B-spline representation	
6.0		**Boundary Description & Object Recognition**	**12**

	6.1	**Texture:** Statistical Texture Description Methods- Methods based on spatial frequencies, co-occurrence matrices, edge frequency, primitive length, Law's texture energy measures	
	6.2	**Object Recognition** Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Support vector machine, cluster analysis	
		Total	**48**

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, "Digital Image Processing", Pearson Education, India, Third Edition,

Reference books:

1. Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India, First Edition, 1989.
2. W Pratt, "Digital Image Processing", Wiley Publication, 3rd Edition, 2002

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6021	Digital VLSI Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 6021	Digital VLSI Design	20	20	20	80	--	--	--	100

Prerequisites:

- Digital System Design
- Microelectronics

Course objectives:

- To highlight the circuit design issues in the context of Digital VLSI technology
- A profound understanding of Digital VLSI design circuits using different design styles.
- To provides an exposure to RTL design and programming

Course outcomes:

After successful completion of the course student will be able to

- Understand the semiconductor technology, scaling and performance.
- Realize logic circuits with different design styles.
- To understand operation of memory, storage circuits and data path elements.
- Simulate and synthesize digital circuits using HDL language.
- Demonstrate an understanding of system level design issues such as protection, clocking, and routing.
- Learn the RTL design techniques and methodologies

Module No.	Unit No.	Topics	Hrs.
1.0		**MOS Circuit Design Styles**	**10**
	1.1	Static CMOS, Dynamic CMOS , Pseudo NMOS, Domino, C^2MOS, NORA logic, NP Domino logic	
	1.2	Realization of Multiplexer (upto 4:1 Mux) , Encoder, Decoder,SR Latch, JK FF, D FF, 1 Bit Shift Register with different design styles and their layouts	
2.0		**Memory and Storage circuits**	**08**
	2.1	ROM array, SRAM (operation, design strategy, leakage currents, read /write circuits), layout of SRAM	
	2.2	DRAM (Operation of 1T, 3T, operation modes, leakage currents, refresh operation, Input-Output circuits), layout of DRAM	
	2.3	Flash memory: NAND and NOR flash memory	
3.0		**Data path design**	**08**
	3.1	Full adder, Ripple carry adder, CLA adder, Carry Skip Adder, Carry Save Adder and carry select adder	
	3.2	Array Multiplier	
	3.3	Barrel shifter	
4.0		**VLSI Clocking, Protection and Interconnect**	**06**
	4.1	CMOS clocking styles, pipelined systems, Clock generation, stabilization and distribution	
	4.2	ESD protection, Input circuits, Output circuits, power distribution scheme	
	4.3	Interconnect delay model, interconnect scaling and crosstalk	
5.0		**Design methods**	**08**
	5.1	Semicustom, Full custom design, ASIC	
	5.2	PLA, PLD, PAL, FPGA	
	5.3	System based and Data path design using HDL	
6.0		**RTL Design**	**08**
	6.1	High Level state machines, RTL design process	
	6.2	Soda dispenser machine, laser based distance measure, Sum of absolute	
	6.3	FIR filter design	
		Total	**48**

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition, 2012.
2. P. Uyemura, "*Introduction to VLSI Circuits and Systems*", John Wiley & Sons.
3. Frank Vahid, " Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.

4. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition.
5. Samir Palnitkar,"Verilog HDL: A Guide to Digital Design and Synthesis", PHI, Second Edition
6. Douglas L. Perry " VHDL: Programming by Example" , McGrawHill, 4th Edition

Reference Books:

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition..
2. Volnei A. Pedroni ,"Circuit Design and Simulation with VHDL", MIT Press, 2nd Edition

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6022	Radar Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 6022	Radar Engineering	20	20	20	80	--	--	--	100

Prerequisties:

- Communication Fundamentals
- Electromagnetic field
- Transmission Lines and Antenna

Course objectives:

- To interpret Radar equations
- To explain different types of radar
- To design RADAR transmitters and receivers for given conditions

Course outcomes:

After successful completion of the course student will be able to

- Explain generalized concept of RADAR.
- Solve problems using radar equations.
- Describe different types of radar for specific application.
- Explain concept of tracking radar.
- Evaluate the design constraints for transmitter.
- Evaluate the design constraints for receiver.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Radar**	**04**
	1.1	Basics Radar, Radar equation	
	1.2	Block Diagram, Radar Frequencies	
	1.3	Applications of Radar	
2.0		**Radar Equation**	**08**
	2.1	Detection of signal in noise	
	2.2	Receiver Noise and Signal-to-noise Ratio	
	2.3	Probability of detection and false alarm: Simple , complex Targets	
	2.4	Pulse Repetition Frequency	
3.0		**MTI and Pulse Doppler Radar**	**12**
	3.1	Introduction to Doppler and MTI radar, Doppler frequency shift	
	3.2	Simple CW Doppler radar, MTI radar block diagram	
	3.3	Delay line canceler	
	3.4	Moving-target-detection	
	3.5	Pulse Doppler radar	
4.0		**Tracking Radar**	**08**
	4.1	Monopulse tracking	
	4.2	Conical scan and sequential lobbing	
	4.3	Limitation of tracking accuracy	
	4.4	Low angle tracking	
5.0		**Radar Transmitters**	**10**
	5.1	Radar RF power sources: Klystron, Travelling wave tube	
	5.2	Solid state RF power source: low power transmitter, high power transmitter, Advantages of solid state RF power source	
	5.3	Magnetron: coaxial magnetron	
	5.4	Crossed field amplifiers: CFA operation, modulating a CFA, system implementation	
6.0		**Radar Receivers**	**06**
	6.1	Receiver noise figure	
	6.2	Superheterodyne Receiver	
	6.3	Radar Display: Types of displays	
		Total	**48**

Text Books:

1. Merill Skolnik, –Introduction to RADAR Systems, Tata McGraw Hill, Third Edition
2. Merill Skolnik, –Radar Handbook, TataMcgraw Hill, Second Edition

Reference books:

1. Mark A. Richards, James A. Scheer, William A. Holm, "Principles of Modern Radar Basic Principals", Scitech Publishing.
2. Simon Kingsley, Shaun Quegon, "Understanding Radar Systems", Scientech Publishing Inc.
3. G. S. N. Raju, "Radar Engineering and Fundamentals of Navigational Aids", I. K International publishing House Pvt. Ltd.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6023	Database Management System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 6023	Database Management System	20	20	20	80	--	--	--	100

Prerequisites:

- Basic knowledge of programming

Course objectives:

- Learn and practice data modeling using the entity-relationship and developing database designs.
- Understand the use of Structured Query Language (SQL) and learn SQL syntax.
- Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access

Course outcomes:

After successful completion of the course student will be able to

- Understand the different issues involved in the design and implementation of a database system.
- Transform an information model into a relational database schema and to use a data definition language and/or utility to implement the schema using a DBMS.
- Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database.
- Understand the concepts of constraints, views, concurrency control, deadlock

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Databases and Transactions**	**02**
	1.1	Introduction to databases, History of database system, Benefits of Database system over file system, relational databases, database architecture, transaction management	
2.0		**Data Models**	**06**
	2.1	The importance of data models, Basic building blocks, Business rules, Evolution of data models (hierarchical, Network, Relational, Entity relationship and object model), Degrees of data abstraction.	
3.0		**Database Design, ER-Diagram and Unified Modeling Language**	**10**
	3.1	Database design and ER Model: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).	
4.0		**Relational Algebra and Calculus**	**10**
	4.1	Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	
5.0		**Constraints, Views and SQL**	**10**
	5.1	What is constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	
6.0		**Transaction management and Concurrency control**	**10**
	6.1	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	
		Total	**48**

Text Books:

1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts", Fifth Edition McGraw-Hill
2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System", Seventh Edition, Person.
4. G. K. Gupta: "Database Management Systems", McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
5. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline

E-Resources:

1. https://www.tutorialspoint.com/dbms/index.htm
2. https://www.studytonight.com/dbms/
3. https://beginnersbook.com/2015/04/dbms-tutorial/
4. https://www.w3schools.in/dbms/
5. https://www.tutorialcup.com/dbms

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6024	Audio Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 6024	Audio Processing	20	20	20	80	--	--	--	100

Prerequisites

- Signal System

Course objectives:

- To understand basic concepts and methodologies for the analysis and modeling of speech signal.
- To characterize the speech signal as generated by a speech production model.
- To understand the mechanism of speech and audio perception.
- To understand the digital representation of the speech waveform.
- To perform the analysis of speech signal using STFT.
- To extract the information of the speech or audio signals.
- To provide a foundation for developing application in this field.

Course outcomes:

After successful completion of the course student will be able to

- Demonstrate advanced Knowledge in Digital model representation of speech signal.
- Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
- Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
- Formulate and design a system for speech recognition and speaker recognition.
- Acquired knowledge about audio and speech signal estimation and detection.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**06**
	1.1	Review of digital signal and systems, Transforms representations of signal and systems, Sampling Theorem, Goertzel algorithm, Chirp algorithm.	
2.0		**Digital Models for Speech signals**	**06**
	2.1	Speech production and acoustic tube modeling, acoustic phonetics, anatomy, and physiology of the vocal tract and ear, hearing and perception.	
3.0		**Digital Representations of the Speech Waveform**	**08**
	3.1	Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, Direct digital code conversion.	
4.0		**Time Domain Models for Speech Processing**	**12**
	4.1	Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech V/S silence discrimination using energy & Zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.	
5.0		**Short time Fourier Transform**	**10**
	5.1	Introduction- Definition and Properties, Fourier Transform Interpretation ,Linear Filtering Interpretation ,Sampling rates of X_n (e^{jw})in Time and Frequency ,Filter Bank Summation Method of Short -Time Synthesis ,Overlap Addition Method for Short -Time Synthesis.	
6.0		**Speech and Audio Processing**	**06**
	6.1	Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders. Adaptive predictive coding of speech, Auditory Modeling. Audio signal processing for Music applications. Speech recognition pattern comparison techniques, Artificial Neural Network.	
		Total	**48**

Text Books:

1. L R Rabiner and S W Schafer, “Digital processing of speech signals”, Pearson Education, 2009.
2. L R Rabiner, B H Juang, B Yegnanarayana, “Fundamentals of speech Recognition”, Pearson Education, 1993.

Reference Books

1. Thomas F Quateri, “ Discrete Time Speech Signal Processing “Pearson Edition,2006.
2. Ben Gold and Nelson Morgan, “Speech & Audio Signal Processing”, wiley, 2007.
3. Douglas O Shaughnessy, “Speech Communications”, 2nd Edition, Oxford university press, 2000.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL601	Microcontroller & Applications Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL601	Microcontroller & Applications Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

1. Perform Arithmetic and Logical Operations
2. Transfer of data bytes between Internal and External Memory
3. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
4. Interfacing of LED,LCD, Stepper Motor, UART

Mini project based on any application related to 8051 or ARM7 can be implemented.

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL602	Computer Communication Network Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL602	Computer Communication Network Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

1. Create a Virtual Network using NETKIT emulator and use networking commands like route, arp, netstat, traceroute, ping on created topology.
2. To study installation and configuration of NS 2.35 simulator.
3. Design a connectionless and connection oriented network topology for static routing and dynamic routing with the help of NS2 simulator.
4. To study three way handshaking process as well as working process for connection oriented Protocols like FTP, TELNET and analysing packets generated by using packet capturing tool like tcpdump
5. To implement stream socket that can serve multiple clients at the same time.
6. To study requirements and scope of Subnetting and Network Translation by using Netkit Emulator.
7. Case Study: To study installation of linux operating system by using DHCP, TFTP and any repository server like HTTP, FTP or NFS.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL603	Antenna & Radio Wave Propagation Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL603	Antenna & Radio Wave Propagation Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Introduction to different Antenna parameters and its importance
- Introduction to Different Antenna Types
- Study of Radiation pattern of dipole, folded dipole and Monopole antenna
- Study of Antenna Arrays – N element array for given angle, Parametric study for various arrays parameters
- Study of Yagi-Uda Antenna
- Study of Aperture Antennas – Horn / Reflector Antennas
- Design, implementation and Pattern measurement of Regular shape MSA
- Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL604	Image Processing and Machine Vision Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL604	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- At least 8 programs written in C/MATLAB software

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6021	Digital VLSI Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 6021	Digital VLSI Design Laboratory	--	--	--	--	25	--	--	25

Suggested Experiment List

1. At least **08** experiments covering entire syllabus of Digital VLSI should be set to have well predefined inference and conclusion.
2. The first 05 experiments as described below can be conducted by using Free or Professional tools
    - **01** experiments on Layouts of NAND and NOR gates to understand design rules
    - **01** experiment on Layout design of logical expression
    - **01** experiments on NAND/NOR gate implementation using at least 03 design styles
    - **02** experiment on Multiplexer/Decoder/Flip flop/Memory etc design
3. Last **03** experiments on HDL

Note: Small Project can be considered as a part of term-work.
Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6022	Radar Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 6022	Radar Engineering Laboratory	--	--	--	--	25	--	--	25

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6023	Database Management System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 6023	Database Management System Laboratory	--	--	--	--	25	--	--	25

Suggested Experiment List

- Design a Database and create required tables. For e.g. Bank, College Database
- Apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.
- Write a sql statement for implementing ALTER, UPDATE and DELETE
- Write the queries to implement the joins
- Write the query for implementing the following functions: MAX (), MIN (), AVG (), COUNT ()
- Write the query to implement the concept of Integrity constrains
- Write the query to create the views
- Perform the queries for triggers
- Perform the following operation for demonstrating the insertion, updation and deletion using the referential integrity constraints
- Write the query for creating the users and their role

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Student Database Management System
6. Employee Management System
7. Inventory Control Management Database

8. Pay Roll Management System
9. Railway System Database
10. Airline Reservation System
11. Blood Donation System
12. School Management System

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6024	Audio Processing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 6024	Audio Processing Laboratory	--	--	--	--	25	--	--	25

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

AC-_____
Item No. _____

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics and Telecommunication Engineering

Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC701	Microwave Engineering	4	-	-	4	-	4
ECC702	Mobile Communication System	4	-	-	4	-	4
ECC703	Optical Communication	4	-	--	4	-	4
ECCDLO 703X	Department Level Optional Course III	4	-	-	4	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	3
ECL701	Microwave Engineering Lab	-	2	-	-	1	1
ECL702	Mobile Communication System Lab	-	2	-	-	1	1
ECL703	Optical Communication Lab	-	2	-	-	1	1
ECLDLO 703X	Department Level Optional Lab III	-	2	-	-	1	1
ECL704	Project-I	-	6	-	-	3	3
Total		**19**	**14**	**-**	**19**	**7**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100
ECC703	Optical Communication	20	20	20	80	03	--	--	100
ECCDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
ECL701	Microwave Engineering Lab	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Lab	--	--	--	--	--	25	25	50
ECL703	Optical Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 703X	Department Level Optional Lab III	--	--	--	--	--	25	25	50
ECL704	Project-I	--	--	--	--	--	50	50	100
Total				**100**	**400**		**150**	**150**	**800**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[#]
ECCDLO7031	Neural Networks and Fuzzy Logic	ILO7011	Product Lifecycle Management
ECCDLO7032	Big Data Analytics	ILO7012	Reliability Engineering
ECCDLO7033	Internet Communication Engineering	ILO7013	Management Information System
ECCDLO7034	CMOS Mixed Signal VLSI	ILO7014	Design of Experiments
ECCDLO7035	Embedded System	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

 # Common with all branches

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC701	Microwave Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC701	Microwave Engineering	20	20	20	80	--	--	--	100

Prerequisites:

- Electromagnetic Engineering
- Antenna and Radio Wave Propagation
- Communication Engineering

Course objectives:

- To learn fundamentals of microwave systems.
- To learn to make system level design decisions.
- To learn passive and active device characteristics

Course outcomes:

After successful completion of the course student will be able to

- Characterize devices at higher frequencies.
- Design and analyze microwave circuits.
- Design and analyze amplifiers and oscillators at microwave frequencies.
- Demonstrate skills of planning, design and deployment of microwave networks.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Microwaves**	**08**
	1.1	Microwave Frequency Bands in Radio Spectrum, Characteristics, Advantages and Applications of Microwaves.	
	1.2	Scattering parameters: Characteristics and Properties.	
	1.3	Strip lines, Microstrip lines and coupled lines: Analysis and design.	
	1.4	Design of Impedance matching network using lumped and distributed parameters.	
2.0		**Waveguides and Passive Devices**	**08**
	2.1	Rectangular and circular waveguides: Construction, Working and Mode analysis.	
	2.2	Resonators, Re-entrant cavities, Tees, Hybrid ring, Directional couplers, Phase shifters, Terminations, Attenuators and Ferrite devices such as Isolators, Gyrators, and Circulators.	
3.0		**Microwave Tubes**	**10**
	3.1	Two Cavity Klystron, Multi-Cavity Klystron and Reflex Klystron.	
	3.2	Helix Travelling Wave Tube and Cross Field Amplifier.	
	3.3	Backward Wave Oscillator, Cylindrical Magnetron and Gyrotron.	
4.0		**Microwave Semiconductor Devices**	**10**
	4.1	Diodes: Varactor, PIN, Tunnel, Point Contact, Schottky Barrier, Gunn, IMPATT, TRAPATT, and BARITT.	
	4.2	Transistors: BJT, Hetro junction BJT, MESFET, and HEMT	
	4.3	Parametric Amplifiers and Applications.	
5.0		**Microwave Measurements**	**06**
	5.1	VSWR, Frequency, Power, Noise, *Q*-Factor, Impedance, Attenuation, Dielectric Constant, Antenna Gain.	
6.0		**Microwave Integrated Circuits (MIC)**	**06**
	6.1	MIC Materials.	
	6.2	Types of MIC: Hybrid and Monolithic MIC.	
	6.3	Chip Mathematics.	
		Total	**48**

Text Books :

1. Samuel Liao, "Microwave Devices and Circuits", Prentice Hall
2. David Pozar, "Microwave Engineering", Wiley Publication, Fourth Edition
3. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education.
4. Annapurna Das and S. K Das, "Microwave Engineering", McGraw Hill Education, Third Edition.

References:

1. Colin, Foundations of Microwave Engineering, Second Edition, Wiley Interscience, 2nd Edition.
2. Devendra Misra, " Radio Frequency and Microwave Communication Circuits- Analysis and Design", John Wiley & Sons, 2nd Edition

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC702	Mobile Communication System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC702	Mobile Communication System	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication
- Digital Communication
- Computer Communication and Networks

Course objectives:

- To understand the cellular fundamentals and different types of radio propagation models.
- To study the system architecture of 2G, 2.5 G and 3G.
- To develop the concepts of emerging technologies for 4 G standards and beyond.

Course outcomes:

After successful completion of the course student will be able to

- Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems.
- Classify different types of propagation models and analyze the link budget.
- Illustrate the fundamentals and system architecture of GSM, 2.5G and IS-95.
- Apply the concepts of 3G technologies of UMTS and CDMA 2000.
- Elaborate the principles of 3GPP LTE.
- Identify the emerging technologies for upcoming mobile communication systems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Fundamentals of Mobile Communication**	**08**
	1.1	**Introduction to wire1ess communication:** Mobile radio telephony, Examples of Wireless Communication Systems, Related design problems.	
	1.2	**The Cellular Concept System Design Fundamentals:** Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems	
2.0		**Mobile Radio Propagation**	**08**
	2.1	**Large scale fading:** Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models	
	2.2	**Small scale fading:** Small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions.	
	2.3	**Features of all conventional multiple access techniques:** Frequency division multiple access(FDMA), time division multiple access(TDMA),space spectrum multiple access (SSMA), space division multiple access (SDMA),OFDM-PAPR,OFDMA	
3.0		**2G Technologies**	**10**
	3.1	**GSM:** GSM Network architecture, GSM signalling protocol architecture, identifiers used in GSM system, GSM channels, frame structure for GSM, GSM speech coding, authentication and security in GSM, GSM call procedures, GSM hand-off procedures, GSM services and features	
	3.2	**GSM evolution:** GPRS And EDGE- architecture, radio specifications, channels.	
	3.3	**IS-95:** Architecture of CDMA system, CDMA air interface, power control in CDMA system, power control, handoff, rake receiver	
4.0		**3G Technology**	**06**
	4.1	**UMTS:** Objectives, standardisation and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels	
	4.2	**Cdma2000 cellular technologies:** Forward And Reverse Channels, Handoff And Power Control.	
5.0		**3GPP LTE**	**08**

	5.1	**Introduction, system overview**: Frequency bands and spectrum flexibility, network structure, protocol structure	
	5.2	**Physical layer**: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques	
	5.3	**Logical and Physical Channels:** Mapping of data onto (logical) sub-channels.	
	5.4	**Physical layer procedures:** Establishing a connection, retransmissions and reliability, scheduling, power control, handover.	
6.0		**Advanced techniques for 4G deployment**	**08**
	6.1	**Multi-antenna Techniques:** Smart antennas, multiple input multiple output systems	
	6.2	**Cognitive radio:** Architecture, spectrum sensing	
	6.3	**Relaying multi-hop and cooperative communications:** Principles of relaying, fundamentals of relaying	
		Total	**48**

Text Books :

1. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON , Second edition.
2. T L Singal “wireless communications”, Mc Graw Hill Education.
3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

References:

1. Upena Dalal “Wireless and Mobile Communications”, Oxford university Press.
2. Vijay K.Garg “Wireless Communications and Networking”,Morgan–Kaufmann series in Networking-Elsevier

E-Resources:

1. MIT Open Course ware : https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-452-principles-of-wireless-communications-spring-2006/
2. NPTL: http://nptel.ac.in/courses/117104099/
3. Virtual Lab : http://vlab.co.in/

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC703	Optical Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC703	Optical Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Physics
- Electromagnetic wave propagation
- Electronics devices and circuits
- Principles of communication

Course objectives:

- List, write and explain fundamentals and transmission characteristics of optical fiber communication
- List, write and explain principles and characteristics of various sources ,detectors and various fiber optic components
- Calculate parameters for optical link budgeting and analyze the link

Course outcomes:

After successful completion of the course student will be able to

- List, write and explain fundamentals and transmission characteristics of optical fiber Communication.
- List, write and explain principles and characteristics of various sources ,detectors and various fiber optic components
- Calculate parameters for optical link budgeting and analyze the link

Module No.	Unit No.	Topics	Hrs.
1.0		**Optical Fiber and their properties**	**10**
	1.1	Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber (no derivations), single mode fiber, cutoff wave length, and mode filed diameter. Wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, loss and bandwidth	
2.0		**Transmission Characteristics of Optical Fiber**	**12**
	2.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion, dispersion and pulse broadening, dispersion shifted and dispersion flattened fibers. General Overview of nonlinearties , Stimulated Raman Scattering, Stimulated Brillouin Scattering , Self Phase modulation , Cross –Phase modulation , Four wave mixing and its mitigation , Solitons. Measurements of attenuation, dispersion and OTDR	
3.0		**Optical Sources**	**06**
	3.1	Working principle and characteristics of sources (LED, LASER), Tunable lasers Quantum well lasers , Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers	
4.0		**Optical Detectors**	**06**
	4.1	Working principle and characteristics of detectors (PIN, APD), Material requirement for RCEPD ,Resonant cavity enhancement (RCE) Photo Detector ,Noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	
5.0		**Fiber Optic Components**	**08**
	5.1	Fiber fabrication (VAD,MCVD), fiber joints, fiber connectors, splices Couplers, multiplexers, filters, fiber gratings, Fabry Perot filters, switches and wavelength converters, Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA.	
6.0		**Optical Link**	**06**
	6.1	Introduction, Point to point links, system considerations, link power budget, and rise time budget. RF over fiber, key link parameters, Radio over fiber links, microwave photonics.	
		Total	**48**

Text Books :

1. Optical Fiber Communication – Gerd Keiser, 4th Ed., MGH, 2008.
2. Optical Fiber Communications– – John M. Senior, Pearson Education. 3rd Impression, 2007.

References:

1. Fiber optics communications-Harold Kolimbiris
2. Introduction to optical fibers, Cheri, McGraw Hill.
3. An introduction to fiber optics, A. Ghatak and K.Thyagrajan, Cambridge Univ, press 10
4. Optical fiber communication and sensors-M. Arumugam Agencies, 20002 optic sensors.
5. Fiber optic communication– Joseph C Palais: 4th Edition, Pearson Education.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7031	Neural networks & Fuzzy Logic	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 7031	Neural networks & Fuzzy Logic	20	20	20	80	--	--	--	100

Prerequisites:

- Numerical Methods
- Optimization Techniques

Course objectives:

- To introduce the concepts and understanding of artificial neural networks
- To provide adequate knowledge about supervised and unsupervised neural networks
- To introduce neural network design concepts
- To expose neural networks based methods to solve real world complex problems
- To teach about the concept of fuzziness involved in various systems and provide adequate knowledge about fuzzy set theory, and fuzzy logic
- To provide knowledge of fuzzy logic to design the real world fuzzy systems

Course outcomes:

After successful completion of the course student will be able to

- Comprehend the concepts of biological neurons and artificial neurons
- Analyze the feed-forward and feedback neural networks and their learning algorithms.
- Calculate Comprehend the neural network training and design concepts
- Analyze the application of neural networks to non linear real world problem
- Comprehend the concept of fuzziness involved in various systems, fuzzy set theory and fuzzy logic
- Apply fuzzy logic to real world problems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Neural Networks and their basic concepts:**	**07**
	1.1	Biological neurons and Artificial neuron, McCulloch-Pitts models *of* neuron, Types of activation functions and Neural Network architectures, Pre-requisites for training of neural networks. Linearly separable and linearly non-separable systems with examples, Features and advantages of Neural Networks over statistical techniques, Knowledge representation, Terminologies related to artificial neural networks, Concepts of Supervised learning, Unsupervised learning, Reinforcement	
2.0		**Supervised Learning Neural Networks:**	**08**
	2.1	Perceptron - Single Layer, Multilayer and their architecture, Error back propagation algorithm, Generalized delta rule, Concept of Training, Testing and Cross-validation data sets for design and validation of networks. Over-fitting. Stopping criterion for training.	
3.0		**Unsupervised Learning Neural Networks:**	**09**
	3.1	Competitive Learning Networks – Maxnet, Mexican Hat Net, Kohonen Self-Organizing Networks – architecture, training algorithm, K-means and LMS algorithms, Radial Basis Function (RBF) neural network – architecture and algorithm, and Discrete Hopfield networks. Introduction to the concept of Support Vector Machine based classifier.	
4.0		**Applications of Neural Networks:**	**06**
	4.1	Applications of Neural networks in pattern classification, Character Recognition**,** Face recognition, Image compression and Decompression	
5.0		**Fuzzy logic:**	**12**
	5.1	Introduction to fuzzy logic, Basic Fuzzy logic theory, Fuzzy sets - properties & operations, Fuzzy relation - Operations on fuzzy relations, Fuzzy Membership functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzification and Defuzzification methods, Fuzzy Inference Systems, Mamdani Fuzzy Models, Fuzzy knowledge based controllers.	
6.0		**Applications of Fuzzy Logic and Fuzzy Systems:**	**06**
	6.1	Fuzzy pattern recognition, fuzzy image processing, Simple applications of Fuzzy knowledge based controllers like washing machines, home heating system, and train break control.	
		Total	**48**

Text Books :

1. S. N. Sivanandam and S. N. Deepa *Introduction to Soft computing,* Wiley India Publications
2. Thimothy J. Ross, *Fuzzy Logic with Engineering Applications,* Wiley India Publications
3. John Yen and Reza Langari, *Fuzzy Logic- Intelligence, Control and Information,* Pearson Publications.
4. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms*, PHI
5. Satish Kumar, *Neural Networks: A classroom Approach,* Tata McGraw-Hill.
6. Meherotra Kishan, Mohan C. K., Ranka Sanjay, *Elements of artificial neural networks*, Penram Publications

References:

1. Hagan, Demuth, and Beale, *Neural Network Design*, Thomson Learning
2. Simon Haykin, *Neural Network- A Comprehensive Foundation,* Pearson Education
3. Christopher M Bishop, *Neural Networks For Pattern Recognition*, Oxford University Press
4. William W Hsieh, *Machine Learning Methods in the Environmental Sciences Neural Network and Kernels,* Cambridge Publications
5. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, *Introduction to Neural Network Using Matlab* Tata McGraw-Hill Publications
6. Bart Kosko, *Neural networks and Fuzzy Systems*, Pearson Education
7. J. S. R. Jang, C.T. Sun, and E. Mizutani, *Neuro-Fuzzy and Soft Computing*, PHI
8. J. M. Zurada, *Introduction to Artificial Neural Systems,* Jaico publishers

Internal Assessment:
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End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7032	Big Data Analytics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 7032	Big Data Analytics	20	20	20	80	--	--	--	100

Prerequisites:

- Data Base Management System

Course objectives:

- To Provide an Overview of an exciting growing field of Big Data Analytics.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
- To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.

Course outcomes:

After successful completion of the course student will be able to

- Understand the key issues in big data management.
- Acquire fundamental enabling techniques using tools in big data analytics.
- Achieve adequate perspectives of big data analytics in various applications like sensor, recommender systems, social media applications etc.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Big Data Analytics**	**06**
	1.1	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach.	
	1.2	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	
2.0		**Hadoop**	**06**
	2.1	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem, Physical Architecture, Hadoop limitations.	
3.0		**NoSQL**	**08**
	3.1	Introduction to NoSQ, NoSQL business drivers, NoSQL case studies.	
	3.2	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns.	
	3.3	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	
4.0		**MapReduce**	**08**
	4.1	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.	
		MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
		Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	
5.0		**Techniques in Big Data Analytics**	**12**
	5.1	Finding Similar Item: Nearest Neighbor Search, Similarity of Documents	
	5.2	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis	
	5.3	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	
	5.4	Frequent Itemset Mining : Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	
6.0		**Big Data Analytics Applications**	**08**

	6.1	Recommendation Systems: Introduction, A Model for Recommendation Systems, Collaborative-Filtering System: Nearest-Neighbor Technique, Example.	
	6.2	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	
		Total	**48**

Text Books :

1. Radha Shankarmani and M Vijayalakshmi "Big Data Analytics", Wiley
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks , "Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
2. Chuck Lam, "Hadoop in Action", Dreamtech Press

Internal Assessment:
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End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7033	Internet Communication Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 7033	Internet Communication Engineering	20	20	20	80	--	--	--	100

Prerequisites:

- Analog communication
- Digital Communication
- Computer Communication and Networks

Course objectives:

- To focus on Internet protocol, standards, services and administration.
- To discuss the Internet security protocol and security services
- To discuss multimedia communication standards and compression techniques
- To discuss the Multimedia communication across the networks

Course outcomes:

After successful completion of the course student will be able to

- Explain the operation of the components of a router including, DHCP, NAT/PAT, Routing function, Switching function.
- Describe how DNS works in the global Internet including caching and root servers.
- Understand the current state-of-the-art developments in Internet technologies for multimedia communications.
- Understand the security protocol and services In the Internet
- Appreciate the principles used in designing multimedia protocols, and so understand why standard protocols are designed the way that they are.
- Understand the system design principles of multimedia communications systems.
- Solve problems and design simple networked multimedia systems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Internet**	**06**
	1.1	What is the Internet, ,Evolution of the Internet, Brief History and Growth of Internet , service description, Network protocol, the network edge	
	1.2	Overview of TCP/IP, layer functions,	
	1.3	Application Layer- Host configuration, DHCP Domain Name System (DNS),Multicast DNS	
	1.4	Remote Login, TELNET and SSH , HTTPs, electronic mail	
2.0		**Transport Layer**	**10**
	2.1	Properties of reliable stream delivery, Overview of TCP segment, TCP connection	
	2.2	Flow control, error control, congestion control	
	2.3	User datagram protocol(UDP) header, pseudo header	
	2.4	SCTP, introduction, Packet format ,	
	2.5	Flow control, error control, congestion control	
3.0		**Internetworking layer**	**08**
	3.1	Overview of Internet protocol (IP) datagram, IP address classes, subnets and supernets	
	3.2	Private IP addresses, classless inter domain routing (CIDR), CIDR subnet addressing, variable length in CIDR subnet addressing, ICMP	
	3.3	Internet Protocol version 6 (IPv6), Packet format, Transition from IPv4 to IPv6, ICMPv6	
4.0		**Internet Security**	**06**
	4.1	Network layer security(AH, ESP, IPsec),	
	4.2	Transport layer security(SSL), Application layer security(secure E mail-PGP, S/MIME),	
	4.3	VPN Firewall, Intrusion Detection System.	
5.0		**Multimedia Communications**	**10**
	5.1	Information Representation- text, images, audio and video, Text and image compression, Audio and video compression, video	
	5.2	compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video	
	5.3	Multimedia Communication Across Networks- Layered video coding, error resilient video coding techniques,	

	5.4	multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, Signalling Protocols: Real-Time Streaming Protocol (RTSP) ,Multimedia across wireless- (Mobiles Networks – Broadcasting Networks – Digital Television infrastructure for interactive multimedia services)	
6.0		**Quality of Services (QoS)**	**08**
	6.1	Integrated services (intserv): Architecture and Service Model, Resource Reservation Protocol (RSVP), Packet Scheduling Disciplines in the Internet	
	6.2	Differentiated Services (diffserv): Framework and Concept, Assured and Expedited Services, Packet Classification, Routers Internals and Packet Dropping Techniques	
		Total	**48**

Text Books :

1. B. Forouzan, ―*TCP/IP Protocol Suite*‖, 4th Edition, McGraw-Hill Publication
2. K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, Multimedia Communication Systems, Prentice Hall India, 2002. ISBN: 81-203-2145-6.

References:

1. Steve Heath, Multimedia and Communication Technology, Second Edition, Focal Press, 2003.
2. ISBN: 81-8147-145-8. Ted Wallingford, ―*Switching to VoIP*‖, Oreilly Publication
3. Fred Halsall, "Multimedia Communications", Pearson education, 2001
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004
5. Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002
6. Tay Vaughan, "Multimedia: Making it Work", 6th edition, Tata McGraw Hill, 2004
7. Pallapa Venkataram, "Multimedia information systems", Pearson education (InPress),2005.
8. Multimedia Communication Techniques and Standards

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

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2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7034	CMOS Mixed Signal VLSI	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 7034	CMOS Mixed Signal VLSI	20	20	20	80	--	--	--	100

Prerequisites:

- Electronic Devices and Circuits I
- Electronic Devices and Circuits II
- Linear Integrated Circuits
- Microelectronics
- Digital VLSI

Course objectives:

- Importance of CMOS and Mixed Signal VLSI design in the field of Electronics and Telecommunication.
- Underlying methodologies for analysis and design of fundamental CMOS Mixed signal Circuits like Data Converters.
- The issues associated with high performance Mixed Signal VLSI Circuits

Course outcomes:

After successful completion of the course student will be able to

- Analyze and design single stage MOS Amplifiers.
- Analyze and design Operational Amplifiers.
- Analyze and design data converter circuits.
- Identify design requirements of analog and mixed signal circuits
- Analyze and design CMOS based switched capacitor circuits
- Understand Oscillators and Phase Locked Loops.

Module No.	Unit No.	Topics	Hrs.
1.0		**Fundamentals of MOS Amplifiers**	**10**
	1.1	MOS Single-stage Amplifiers: Basic concepts of common source stage, source follower, common gate stage, Differential Amplifiers:	
	1.2	Current mirrors: Basic current mirror, cascode current mirror, active current mirror, Wilson and Widlar current mirrors, voltage and current references.	
2.0		**Design of MOS operational amplifier**	**08**
	2.1	General considerations, One-Stage Op amps, Two-Stage Op amps, Gain Boosting, Input Range Limitation.	
	2.2	Frequency Response and Compensation, Slew Rate.	
3.0		**Oscillators and Phase Locked Loops**	**08**
	3.1	General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators (VCO), tuning range, tuning linearity Mathematical Model of VCO.	
	3.2	Simple PLL-phase detector, Charge-pump PLL's, Non ideal effects in PLL, Delay locked Loops, applications of PLL.	
4.0		**Switched Capacitor circuits**	**06**
	4.1	Theory of sampled data systems, Basic sampling circuits for analog signal sampling, performance metrics of sampling circuits, design and analysis of switched capacitor circuits.	
	4.2	Switched capacitor amplifiers (SC), switched capacitor integrators, first and second order switched capacitor circuits.	
5.0		**Data converters**	**06**
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations.	
6.0		**Data Converter Architectures**	**10**
	6.1	DAC architectures: R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC, Switched capacitor based DAC design.	
	6.2	ADC architectures: flash, 2-step flash ADC, pipeline ADC, integrating ADC, and successive approximation ADC, Switched capacitor based ADC design	
		Total	**48**

Text Books :

1. Razavi, “Design of analog CMOS integrated circuits”, McGraw Hill, Edition 2002.
2. Jacob Baker, “CMOS Mixed-Signal circuit design”, IEEE Press, 2009.
3. P. E. Allen and D R Holberg, **“***CMOS Analog Circuit Design***”**, second edition, Oxford University Press, 2002.
4. Baker, Li, Boyce, “CMOS: Circuit Design, layout and Simulation”, PHI, 2000.
5. Sedra/Smith, “Microelectronic Circuits”, Oxford University Press.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duation of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7035	Embedded Systems	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 7035	Embedded Systems	20	20	20	80	--	--	--	100

Course objectives:

- To develop background knowledge Embedded Systems.
- To understand communication techniques.
- To write programs for embedded systems and real time operating sytems

Course outcomes:

After successful completion of the course student will be able to

- Understand the detailed processor design techniques and methods of communication.
- Study the in-depth program modelling concepts.
- Study the concepts of Real time operating systems and write programs
- Design embedded system applications using RTOS

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction:-**	**08**
	1.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas	
	1.2	Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle	
	1.3	**Program modeling concepts:** DFG, FSM, Petri-net, UML	
2.0		**Processor**	**08**
	2.1	Overview of Custom Single-Purpose Processors, General-Purpose Processors,	
	2.2	Parallel Port example, Standard Single-Purpose Processors	
	2.3	RISC and CISC architectures	
	2.4	GCD example	
3.0		**Communication**	**06**
	3.1	CAN bus, I2C, MOD bus, SPI,	
	3.2	Examples on Parallel Communication, Serial Communication, Wireless Communication	
4.0		**Real Time Operating Systems[RTOS]**	**07**
	4.1	Operating system basics	
	4.2	Types of OS	
	4.3	Tasks, process,Threads	
	4.4	Multiprocessing and ,Multitasking	
	4.5	Task scheduling	
	4.6	Threads, Process , Scheduling :- Putting them all together	
5.0			**07**
	5.1	Task communications,	
	5.2	Task synchronization	
	5.3	Device drivers	
	5.4	How to choose RTOS	
	5.5	Examples of RTOS	
6.0		**Design examples and case studies of program model and programming with RTOS**	**12**
	6.1	Digital Camera:-Introduction to simple digital camera, Requirements and specifications, Design using Microcontroller and Microcontroller and CCDPP	
	6.2	Automatic Chocolate Vending Machine	
	6.3	Adaptive Cruise Control in car	
		Total	**48**

Text Books :

1. Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication.
2. Raj Kamal," Embedded Systems Architecture, Programming and design", Tata MCgraw-Hill Publication.
3. Iyer, Gupta," Embedded real systems Programming", TMH
4. David Simon, "Embedded systems software primer', Pearson
5. Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
6. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming",Dreamtech Publication.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7011	Product Lifecycle Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7011	Product Lifecycle Management	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course outcomes:

After successful completion of the course student will be able to

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Product Lifecycle Management (PLM)**	**10**
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications	
	1.2	**PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	
2.0		**Product Design**	**09**
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3.0		**Product data Management**	**05**
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
4.0		**Virtual Product Development Tools**	**05**
	4.1	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
5.0		**Integration of Environmental Aspects in product Design**	**05**
	5.1	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
6.0		**Life Cycle Assessment and Life Cycle Cost Analysis**	**05**

	6.1	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
		Total	**39**

References :

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7012	Reliability Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7012	Reliability Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Course outcomes:

After successful completion of the course student will be able to

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module No.	Unit No.	Topics	Hrs.
1.0		**Probability Theory**	**08**
	1.1	Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	
2.0			**08**
	2.1	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	
3.0		**System Reliability**	**05**
	3.1	System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	
4.0		**Reliability Improvement**	**08**
	4.1	Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
5.0		**Maintainability and Availability**	**05**
	5.1	System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
6.0		**Failure Mode, Effects and Criticality Analysis**	**05**
	6.1	Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	
		Total	**39**

References :

1. L. S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.

2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B. S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7013	Management Information System	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7013	Management Information System	20	20	20	80	--	--	--	100

Course objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Course outcomes:

After successful completion of the course student will be able to

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction To Information Systems (IS)**	**04**
	1.1	Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	
2.0		**Data and Knowledge Management**	**07**
	2.1	Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management **Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Presenting Results	
3.0		**Ethical issues and Privacy**	**07**
	3.1	Information Security. Threat to IS, and Security Controls	
4.0		**Social Computing (SC)**	**07**
	4.1	Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
5.0			**06**
	5.1	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	
6.0		**Information System within Organization**	**08**
	6.1	Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	
		Total	**39**

References :

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K. C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7014	Design of experiments	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7014	Design of experiments	20	20	20	80	--	--	--	100

Course objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Course outcomes:

After successful completion of the course student will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**06**
	1.1	Strategy of Experimentation	
	1.2	Typical Applications of Experimental Design	
	1.3	Guidelines for Designing Experiments	
	1.4	Response Surface Methodology	
2.0		**Fitting Regression Models**	**08**
	2.1	Linear Regression Models	
	2.2	Estimation of the Parameters in Linear Regression Models	
	2.3	Hypothesis Testing in Multiple Regression	
	2.4	Confidence Intervals in Multiple Regression	
	2.5	Prediction of new response observation	
	2.6	Regression model diagnostics	
	2.7	Testing for lack of fit	
3.0		**Two-Level Factorial Designs**	**07**
	3.1	The 2^2 Design	
	3.2	The 2^3 Design	
	3.3	The General2^k Design	
	3.4	A Single Replicate of the 2^k Design	
	3.5	The Addition of Center Points to the 2^k Design,	
	3.6	Blocking in the 2^k Factorial Design	
	3.7	Split-Plot Designs	
4.0		**Two-Level Fractional Factorial Designs**	**07**
	4.1	The One-Half Fraction of the 2^k Design	
	4.2	The One-Quarter Fraction of the 2^k Design	
	4.3	The General 2^{k-p} Fractional Factorial Design	
	4.4	Resolution III Designs	
	4.5	Resolution IV and V Designs	
	4.6	Fractional Factorial Split-Plot Designs	
5.0		**Response Surface Methods and Designs**	**07**
	5.1	Introduction to Response Surface Methodology	
	5.2	The Method of Steepest Ascent	
	5.3	Analysis of a Second-Order Response Surface	
	5.4	Experimental Designs for Fitting Response Surfaces	
6.0		**Taguchi Approach**	**04**
	6.1	Crossed Array Designs and Signal-to-Noise Ratios	
	6.2	Analysis Methods	
	6.3	Robust design examples	
		Total	**39**

References :

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7015	Operations Research	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7015	Operations Research	20	20	20	80	--	--	--	100

Course objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models

Course outcomes:

After successful completion of the course student will be able to

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Operations Research**	**14**
	1.1	Introduction, , Structure of the Mathematical Model, Limitations of Operations Research	
	1.2	**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,	
	1.3	**Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	
	1.4	**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.	
	1.5	**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	
	1.6	**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2.0		**Queuing Models**	**05**
	2.1	Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	
3.0		**Simulation**	**05**
	3.1	Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
4.0		**Dynamic programming**	**05**
	4.1	Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	
5.0		**Game Theory**	**05**

	5.1	Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
6.0		**Inventory Models**	**05**
	6.1	Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	
		Total	**39**

References :

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7016	Cyber Security and Laws	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7016	Cyber Security and Laws	20	20	20	80	--	--	--	100

Course objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Cybercrime**	**04**
	1.1	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the	
2.0		**Cyber Offenses & Cybercrime**	**09**
	2.1	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
3.0		**Tools and Methods Used in Cyberline**	**06**
	3.1	Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4.0		**The Concept of Cyberspace**	**08**
	4.1	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
5.0		**Indian IT Act**	**06**
	5.1	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
6.0		**Information Security Standard compliances**	**06**
	6.1	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	
		Total	**39**

References :

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai

5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7017	Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7017	Disaster Management and Mitigation Measures	20	20	20	80	--	--	--	100

Course objectives:

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Course outcomes:

After successful completion of the course student will be able to

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**03**
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change	
2.0		**Natural Disaster and Manmade disasters**	**09**
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion	
	2.2	Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters	
3.0		**Disaster Management, Policy and Administration**	**06**
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management	
	3.2	**Policy and administration:** Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4.0		**Institutional Framework for Disaster Management in India**	**06**
	4.1	Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.	
		Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
5.0		**Financing Relief Measures**	**09**
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.	
	5.2	International relief aid agencies and their role in extreme events	
6.0		**Preventive and Mitigation Measures**	**06**

	6.1	Pre-disaster, during disaster and post-disaster measures in some events in general	
	6.2	Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication	
	6.3	Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans	
	6.4	Do's and don'ts in case of disasters and effective implementation of relief aids.	
		Total	**39**

References :

1. Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7018	Energy Audit and Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7018	Energy Audit and Management	20	20	20	80	--	--	--	100

Course objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course outcomes:

After successful completion of the course student will be able to

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module No.	Unit No.	Topics	Hrs.
1.0		**Energy Scenario**	**04**
	1.2	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	
2.0		**Energy Audit Principles**	**08**
	2.1	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	
3.0		**Energy Management and Energy Conservation in Electrical System**	**10**
	3.1	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. **Energy conservation opportunities in**: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
4.0		**Energy Management and Energy Conservation in Thermal Systems**	**10**
	4.1	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
5.0		**Energy Performance Assessment**	**04**
	5.1	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	
6.0		**Energy conservation in Buildings**	**03**

	6.1	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	
		Total	**39**

References :

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Internal Assessment:
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3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7019	Development Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 7019	Development Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
- To understand the Nature and Type of Human Values relevant to Planning Institutions

Course outcomes:

After successful completion of the course student will be able to

- Apply knowledge for Rural Development.
- Apply knowledge for Management Issues.
- Apply knowledge for Initiatives and Strategies
- Develop acumen for higher education and research.
- Master the art of working in group of different nature.
- Develop confidence to take up rural project activities independently

Module No.	Unit No.	Topics	Hrs.
1.0			**08**
	1.1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
2.0			**04**
	2.1	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
3.0			**06**
	3.1	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
4.0			**04**
	4.1	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	
5.0			**10**

	5.1	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
6.0			**04**
	6.1	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
		Total	**36**

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

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2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL701	Microwave Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL701	Microwave Engineering Laboratory	--	--	--	--	25	25	--	50

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL702	Mobile Communication System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL702	Mobile Communication System Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency
- To observe the effect of N on C/I ratio and comment on the voice quality
- To observe the effect of incidence angle on reflection coefficient using MATLAB
- To observe the effect of different propogation models on coverage distance
- To observe the effect of C/I ratio in a sectorised cell site and perform worst case analysis for different values of N and degree of sectorisation
  A) Worst case C/I in a 3 sector cellular system for K=7
  B) Worst case C/I in a 3-sector cellular system for K=4
  C) Worst case C/I in a 6 sector cellular system for K=7
  D) Worst case C/I in a 6 sector cellular system for K=4
- To generate Pseudo noise code used in a CDMA system
- To generate Walsh Codes using Hadamard Matrix.
- To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter
- To plot channel capacity versus SNR for different MIMO systems
- Simulation of OFDMA system
- Simulation of spectrum sensing using energy detection method in cognitive radio

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Developing automated Notification based System using GSM

2. Mobile Communication Based App development
3. Creating Virtual Lab Experiments**.**

Software Tools:

1. Ns-2: http://www.isi.edu/nsnam/ns/
2. Virtual Lab : http://vlab.co.in/
3. Scilab Experiments Book: http://www.scilab.in/textbook_companion/generate_book/2081

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL703	Optical Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL703	Optical Communication Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Calculation of Numerical aperture
- Calculation of dispersion for given fiber
- Calculation of link Loss for given link
- Performance analysis of Single mode fiber
- Performance Analysis of Optical Link with Different Sources
- Performance Analysis of Optical Link with Different Detectors
- Performance Analysis of Optical Amplifier
- Calculation of link Loss for given link with nonlinearities

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7031	Neural networks & Fuzzy Logic Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 7031	Neural networks & Fuzzy Logic Laboratory	--	--	--	--	25	25	--	50

Suggested List of Experiments

- Write a program for implementing perceptron based linear functions AND and OR function. Conclude about the noise tolerance of the function.
- Write a program for implementing optimal neural network based XOR functions. Conclude about the noise tolerance of the function
- Write a program for training and testing of Multilayer Perceptron for pattern classification application
- Write a program for training and testing of Multilayer Perceptron for interpolation application
- Program for Support vector Machine based classifiers and compare result with that of Multilayer Perceptron based neural network classification
- Program for application of Multilayer perceptron for character recognition
- Program to develop Fuzzy Inference System for Speed control of DC motor
- Program for fuzzy logic based train brake control with suitable input variable assumptions
- Program to develop Fuzzy Inference System for fuzzy control of washing machines

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project

can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7032	Big Data Analytics Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 7032	Big Data Analytics Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Study of Hadoop ecosystem
- Programming exercises on Hadoop
- Programming exercises in No SQL
- Implementing simple algorithms in Map- Reduce - Matrix multiplication, Aggregates.

List of Mini project

1. Design and implementation of any case study/ applications based on standard Datasets available on the web

a. Twitter data analysis b. Fraud Detection c. Text Mining etc. using modern tools.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades

will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7033	Internet Communication Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 7033	Internet Communication Engineering Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Simulation study on congestion control
- Multimedia networking
- Multimedia streaming
- Assignments / Practicals can be given on writing the programs to encode and decode the various kinds of data by using the algorithms. Students can collect several papers from journals/conferences/Internet on a specific area of Internet and multimedia communications and write a review paper and make a presentation.
- Form small groups to complete projects in audio, image and video coding. The use of C/C++ is encouraged
- Conduct network simulations using OPNET and protocol analysis using Wireshark.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECLDLO 7034	CMOS Mixed Signal VLSI Laboratory	--	--	02	--	--	01	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 7034	CMOS Mixed Signal VLSI Laboratory	--	--	--	--	25	25	--	50

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7035	Embedded System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 7035	Embedded System Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Interfacing of I2C,CAN,SPI,zigbee etc with ARM
- Simulation of multitasking using RTOS
- Simulation of mutex using RTOS
- Simulation of mailboxes using RTOS
- Interprocess communication using semaphore in RTOS
- Simulation of message queues using RTOS

Minimum One project based on any application related to RTOS and embedded system can be implemented.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL704	Project Stage-I	--	06	--	--	3	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL704	Project Stage-I	--	--	--	--	50	50	--	100

Objective: The Project work enables the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a specific problem or issue, via a substantial piece of work which is carried out over an extended period. It also enables the students to demonstrate the proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. **Project Topic:**
   - To proceed with the project work it is very important to select a right topic. Project can be undertaken on any domain of electronics and telecommunication programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
   - Project work must be carried out by the group of at least two students and maximum four and must be original.
   - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
   - The project work can be undertaken in a research institute or organization/company/any business establishment.
   - Student must consult internal guide along with external guide (if any) in selection of topic.
   - Head of department and senior staff in the department will take decision regarding selection of projects.
   - Student has to submit weekly progress report to the internal guide and whereas internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding the term work marks.

- In case of industry projects, visit by internal guide will be preferred.

2. **Project Report Format:**

   At the end of semester a project report should preferably contain at least following details:-
   - Abstract
   - Introduction
   - Literature Survey
     a) Survey Existing system
     b) Limitation of the Existing system or research gap
     c) Problem Statement and Objective
     d) Scope
   - Proposed System
     a) Analysis/Framework/ Algorithm
     b) Details of Hardware & Software
     c) Design details
     d) Methodology (your approach to solve the problem)
   - Implementation Plan for next semester
   - Conclusion
   - References

3. **Term Work:**
   Distribution of marks for term work shall be as follows:
     a) Weekly Attendance on Project Day
     b) Contribution in the Project work
     c) Project Report (Spiral Bound)
     d) Term End Presentation (Internal)

   The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**

   Oral &Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project- I.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC801	RF Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC801	RF Design	20	20	20	80	--	--	--	100

Prerequisites:

- Electromagnetic Engineering
- Antenna & Radio Wave Propagation
- Communication Engineering
- Microwave Engineering

Course objectives:

- To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver
- To learn importance of EMI/EMC

Course outcomes:

After successful completion of the course student will be able to

- Design impedance matching networks and passive RF filters.
- Design and appraise RF amplifiers and oscillators.
- Analyze EMI and EMC in RF circuits.

Module No.	Unit No.	Topics	Hrs.
1.0		**RF Filter Design**	**10**
	1.1	Image parameter method	
	1.2	Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation	
2.0		**Amplifier Design**	**08**
	2.1	Two-port power gain stability	
	2.2	Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design	
	2.3	Power amplifier design.: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier	
3.0		**Frequency Generation & Mixer**	**08**
	3.1	One-port and two-port microwave oscillator design.	
	3.2	Analysis of phase noise in oscillators.	
	3.3	Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers.	
4.0		**Frequency Synthesizers**	**06**
	4.1	Direct Frequency Synthesis, Frequency Synthesis by Phase Lock, Effects of Reference Frequency on Loop Performance,	
	4.2	Variable-Modulus Dividers, Down Conversion, Methods for Reducing Switching Time, Direct Digital Synthesis, Synthesizer Design .	
	4.3	Phase Noise: A Model for Oscillator Phase Noise, Phase Noise in Phase-Locked Loops, Effect of Frequency Division and Multiplication on Phase Noise.	
5.0		**Electromagnetic Interference in RF circuits**	**08**
	5.1	Introduction. Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. **Quantification Of Communication System EMI**	
	5.2	Elements Of Interference, Including Antennas, Transmitters, Receivers And Propagation. **Electronic Equipment And System EMI Concepts.** Examples Of EMI Coupling Modes	
	5.3	**Equipment Emissions And Susceptibilities- Types of coupling: Common-Mode Coupling:** Common-Mode Coupling Mechanisms Including Field To Cable, Ground Impedance, Ground Loop And Coupling Reduction Techniques **Differential-Mode Coupling** : Differential-Mode Coupling Mechanisms Including Field To Cable, Cable To Cable And Coupling Reduction Techniques.	
	5.4	**Other Coupling mechanisms:** Power Supplies And Victim Amplifiers	

6.0		**Electromagnetic Compatibility**	**08**
	6.1	**The Importance Of Grounding For Achieving EMC.** Grounding, Including The Reasons (I.E., Safety, Lightning Control, EMC, Grounding Schemes (Single Point, Multi-Point And Hybrid), Shield Grounding And Bonding. Shielding Effectiveness, Shielding Considerations (Reflective And Absorptive), Shielding Compromises (I.E., Apertures, Gaskets, Waveguide Beyond Cut-Off)	
	6.2	**EMI Diagnostics And Fixes:** Techniques Used In EMI Diagnostics And Fixes	
	6.3	**EMC Specifications, Standards And Measurements.** A Discussion Of The Genesis Of EMC Documentation Including A Historical Summary, The Rationale, And A Review Of MIL-Stds, FCC And CISPR Requirements.	
		Total	**48**

Text Books

1. David M Pozar, Microwave Engineering, John Wiely and Sons, 2005
2. Ludwig R. and Bogdanov G, RF Circuit Design, Prentice Hall, 2007.
3. Jack Smith, Modern Communication circuits,Tata McgrawHill.
4. W. Prasad Kodali, Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models, 2nd Edition, ISBN: 978-0-7803-4743-4, January 2001, Wiley-IEEE Press
5. David. A. Weston, Electromagnetic Compatibility-principles and applications, Second Edition, Publisher: Marcel Dekker, Inc. 2001, ISBN 0-8247-8889-3

References:

1. Guillermo Gonzalez, 'Microwave Transistor Amplifiers Analysis and Design', Prentice Hall, 2nd Edition.
2. Devendra Misra, 'Radio Frequency and Microwave Communication Circuits-Analysis and Design', John Wiley & Sons, 2nd Edition.
3. Clayton R. Paul, 'Electromagnetic Compatibility', John Wiley & Sons, 2nd Edition.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC802	Wireless Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC802	Wireless Networks	20	20	20	80	--	--	--	100

Prerequisites:

- Mobile Communication

Course objectives:

- Introduction to wireless Body Networks and study emerging technologies like Bluetooth and Zigbee
- To study Wireless LAN, PAN & MAN.
- Understanding Ultra Wideband communication.
- Introduction to Femtocells

Course outcomes:

After successful completion of the course student will be able to

- Explain the working of different wireless technologies like bluetooth and zigbee.
- Understand the working of wireless LAN, PAN & MAN
- Analyze the different types of Wireless Networks like LAN,PAN & MAN
- Comprehend the working of Femtocells.

Module No.	Unit No.	Topics	Hrs.
1.0		**Wireless Body Area Networks**	**12**
	1.1	Introduction to WBAN, Network Architecture, Network Components	
	1.2	Network Protocol: Physical Layer, Data Link layer, Media Access Control (MAC) Layer, Network Layer	
	1.3	**WBAN Technologies:** Bluetooth: Concept of Piconet, Scatternet, Protocol Stack Connection establishment **Zigbee:** Components, Protocol Stack, Architecture & Network Topologies	
2.0		**Wireless LAN**	**10**
	2.1	Introduction to wireless LAN, Transmission Techniques	
	2.2	Medium Access Control Protocol Issues: Hidden Terminal Problem, Reliability, Collision Avoidance, Congestion Avoidance, Congestion Control, Energy Efficiency	
	2.3	IEEE 802.11 Standard for Wireless LAN: Network Architecture, Physical Layer, MAC Layer, Security, System design and considerations	
	2.4	Enhancements to IEEE 802.11 MAC: Power Control, Spatial Reusability & QoS Provisioning	
3.0		**Wireless PAN**	**08**
	3.1	Introduction to wireless PAN, Need of Wireless PAN	
	3.2	Bluetooth Technology: History & Applications, Technical Overview, Bluetooth Specifications, Piconet Synchronization, master-slave switch, Bluetooth security.	
	3.3	Enhancements to Bluetooth: Bluetooth Interface issues, Intra & Inter Piconet Scheduling, Scatternet Formation, QoS Assignment	
	3.4	IEEE 802.15 Working group for WPAN, IEEE 802.15.3 & IEEE 802.15.4	
	3.5	Comparison between WPAN System & Comparison between WLAN & WPAN	
4.0		**Wireless MAN**	**08**
	4.1	Introduction to Wireless Metropolitan Area Networks, IEEE 802.16 Standards Advantages of IEEE 802.16	
	4.2	WMAN Network Architecture: Network Components, features of WiMAX, WiMAX Mobility Support	
	4.3	Network Protocols : Physical Layer, MAC Layer	
		WMAN Applications: Banking Networks, Educational Networks, Public Safety	
5.0		**Ultra wideband Communication**	**06**
	5.1	Introduction, UWB indoor channel, UWB capacity	

	5.2	Pulsed UWB: Pulse shape, Modulation & Multiple access techniques, Pulsed UWB transceivers,	
	5.3	Multiband UWB: Modulation of pulsed multiband UWB, MB-OFDM UWB	
6.0		**Femtocells**	**04**
	6.1	Introduction to Femtocell, Femtocell Attributes, Femtocell Standards,	
	6.2	Concept of Femtocells, Types of Femtocells	
	6.3	Applications of Femtocells.	
		Total	

Text Books & References :

1. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, "AD HOC & Sensor Networks – Theory & Applications ", Cambridge University Press India Pvt. Ltd.
2. KE- LIN DU & M. N. S. Swamy, "Wireless Communication Systems", Cambridge University Press India Pvt. Ltd.
3. D. E. Comer, "Femtocells- Opportunity & Challenges for Business & Technology", Wiley Publications.
4. Dr. Sunilkumar S. Manvi, Mahabaleshwar S. kakkasageri, "Wireless & Mobile Networks: Concepts and Protocols".

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8041	Optical Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8041	Optical Networks	20	20	20	80	--	--	--	100

Prerequisites:

- Principles of Communication Engineering
- Digital Communication
- Antenna Wave Propagation
- Optical Communication

Course objectives:

- The issues related to signal degradation due to linear impairment
- High data rate WDM optical transport networks
- Link budget and optical networks, design and management.

Course outcomes:

After successful completion of the course student will be able to

- Identify the issues related to signal degradation and multiplexing.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.
- Apply the knowledge developed in-class to contemporary optical fiber communication research and industrial areas.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Optical Components and Networks**	**06**
	1.1	OPTICAL Components - Couplers, Isolators and Circulators, Multiplexes and Filters Optical Amplifiers. Transmitters, Detectors, Switches, Wavelength Converters	
	1.2	OPTICAL Networks - Telecommunication networks, First generation optical networks, Multiplexing techniques, Second generation optical networks, System and network evolution	
2.0		**Optical Networks Architecture**	**08**
	2.1	SONET/SDH, Computer interconnects, MANS, Layered architecture for SONET and second generation networks.	
	2.2	Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols,	
	2.3	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons	
3.0		**Packet Switching and Access Networks**	**08**
	3.1	Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing,	
	3.2	Synchronization, Broadcast OTDM networks, Switch-based networks	
	3.3	Access Networks – Network Architecture overview, Future Access Networks,	
	3.4	Optical Access Networks Architectures; and OTDM networks	
4.0		**Wavelength Routing Networks**	**10**
	4.1	Optical layer, Node design, Network design and operation, routing and wavelength assignment architectural variations	
	4.2	Optical Network Routing Principles - Impairment Aware Routing Optical Circuit Switching ,Optical Packet Switching Optical Burst Switching	
	4.3	Energy Awareness in Optical Networking ,Network Modeling Tools Network Design Guidelines	
5.0		**Design of Optical Networks**	**10**
	5.1	Core Optical Networks, Metro Optical networks, Access Optical Networks	
	5.2	Wavelength Routing and Assignment, Traffic Grooming and Protection, Multilayer Network Structure	
	5.3	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization	
6.0		**Virtual topology, Network Control and Management**	**06**
	6.1	Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies,	

	6.2	Control and management, Network management configuration management, Performance management, fault management. Network management functions, Optical safety	
		Total	**48**

Text Books :

1. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Optical Networks: A Practical Perspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
2. Harry G. Parros, Communication Oriented Networks, Wiley
3. G. Agrwal, Fiber Optic Communication Systems, John Wiley and Sons, 3rd Edition, New York, 2014.

References:

1. C. Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice Hall of India, 1st Edition, 2002.
2. Biswajit Mukherjee, Optical Communication Networks, TMG1998.
3. Jane M. Simoons, Optical Network Design and Planning, Second Edition, Springer
4. Ulysees Black, Optical Networks, Pearson education 2007.
5. Milorad Cvijetic, Ivan B. Djordjevic, Advanced Optical Communication Systems and Networks, Artech House Applied Photonics, 2012.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8042	Advanced Digital Signal Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8042	Advanced Digital Signal Processing	20	20	20	80	--	--	--	100

Prerequisites:

- Discrete Time Signal Processing

Course objectives:

The aim of this course is to provide in-depth treatment on methods and techniques on

- Multirate Signal Processing, Power Spectrum Estimation, Adaptive Filtering and Wavelet Transform.
- Application of signal processing to real world problems.

Course outcomes:

After successful completion of the course student will be able to

- Demonstrate an understanding of multirate sampling and its mechanism.
- Study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
- Implement adaptive filters for given applications.
- Apply signal processing tools to Biomedical and Telecommunication Applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Multirate Digital Signal Processing**	**08**
	1.1	Advantages of Multirate Signal Processing	
	1.2	Interpolation and Decimation	
	1.3	Sampling Rate Conversion by Non Integer Factor	
	1.4	Multistage Interpolation and Decimation	
	1.5	Polyphase Decomposition	
	1.6	Digital Filter Banks	
	1.7	Applications of Multirate Signal Processing	
2.0		**Power Spectrum Estimation**	**10**
	2.1	**Non Parametric Method of Power Spectrum Estimation:** Periodogram, Modified Periodogram, Barlett Method, Welch's Method, Blackman-Tukey Approach	
	2.2	**Parametric Methods of Power Spectrum Estimation:** Auto Regressive Spectrum Estimation, Model Parameters-Yule-Walker Equation, Least Square Method and Linear Prediction, Moving Average Spectrum Estimation, Autoregressive Moving Average Spectrum Estimation	
	2.3	Eigen Analysis Algorithm for Spectrum Estimation	
3.0		**Linear Prediction and Optimum Linear Filters**	**10**
	3.1	Representation of Stationary Random Process	
	3.2	Forward and Backward Linear Prediction	
	3.3	Solution of Normal Equation(Levinson-Durbin and Schur Algorithm)	
	3.4	AR Lattice and ARMA Lattice Ladder Filters	
	3.5	Weiner Filters for Filtering and Prediction	
4.0		**Adaptive Filters**	**10**
	4.1	**Applications of Adaptive Filters:** System Identification, Adaptive Channel Equalization, Echo Cancellation, Adaptive Noise Cancellation, Suppression of Narrowband Interference in Wideband Signals, Adaptive Arrays.	
	4.2	**Adaptive Algorithms:** LMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm	
5.0		**Wavelet Transform**	**06**
	5.1	Introduction to Time Frequency Analysis	
	5.2	Short Time Fourier Transform	
	5.3	Continuous Wavelet Transform	
	5.4	Discrete Wavelet Transform	
	5.5	Multiresolution Analysis	

	5.6	Applications	
6.0		**Application Of Signal Processing**	**04**
	6.1	Biomedical Applications	
	6.2	Audio Applications	
	6.3	Telecommunication Applications(Radar)	
		Total	**48**

Textbooks

1. John G. Proakis, Dimitris G. Monolakis " Digital Signal Processing", PHI 2007.
2. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing A Practical Approach", Pearson Education 2008.

Reference Books

1. Simon Haykin, "Adaptive Filter Theory", Pearson Education 2013.
2. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press.
3. Raghuveer M. Rao and Ajit S. Bopardikar, "Wavelet Transforms", "Introduction to Theory and Applications", Pearson Education Asia 2000.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8043	Satellite Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8043	Satellite Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication
- Digital Communication

Course objectives:

- To understand the basics of satellite communications and different satellite communication orbits
- Provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology
- To explain the tools necessary for the calculation of basic parameters in a satellite communication system.
- Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite

Course outcomes:

After successful completion of the course student will be able to

- Explain basics of satellite communication, space segment and earth segment
- Understand different satellite orbits and orbital parameters
- Explain and analyze link budget of satellite signal for proper communication
- Understand various applications of satellite communications

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of Satellite Systems, Orbits and Launching**	**09**
	1.1	An overview of space and satellite, Frequency allocation for satellite communication, Polar orbiting satellites, Kepler's First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations, effects of a non-spherical earth, atmospheric drag	
	1.2	Wave Propagation & Polarization, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other impairments, Antenna Polarization, Polarization of Satellite signals, Cross polarization discrimination, Ionospheric depolarization, Rain depolarization, Ice depolarization	
	1.3	Sub-satellite Point, predicting satellite position, antenna look angels, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage	
	1.4	Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, launch vehicles; satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	
2.0		**Space Segment**	**06**
	2.1	Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system, reliability and quality Assurance.	
3.0		**Earth station**	**05**
	3.1	Design consideration	
	3.2	General configuration- Block diagram, Receive only type earth, transmit-receive type earth station, Antenna system, Feed system, Tracking system, LNA, HPA	
4.0		**Satellite Links**	**10**
	4.1	Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget	
	4.2	System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature, carrier to noise ratio	
	4.3	Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output	
	4.4	Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, inter-modulation noise	
5.0		**The Space Segment Access and Utilization**	**08**
	5.1	Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	

	5.2	TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA	
	5.3	Code Division Multiple Access: Direct-sequence spread spectrum–acquisition and tracking, spectrum spreading and dispreading – CDMA throughput	
6.0		**Satellite Applications**	**10**
	6.1	VSAT systems: Advantages, configurations, frequency bands, elements, Applications	
	6.2	Broadcast services: Television broadcast systems, DAB,	
	6.3	Mobile satellite communication: INMARSAT, LMSS, mobile satellite systems with non GEO satellites	
	6.4	Satellite navigation systems	
	6.5	Laser Satellite Communication: Link analysis, optical satellite link transmitter, optical satellite link receiver, satellite beam acquisition, tracking & positioning, deep space optical communication link	
	6.6	Recent applications	
	6.7	Modern development and future trends	
		Total	**48**

Text Books & References :

1. Dennis Roddy, “Satellite Communications”, 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, “Satellite Communication Systems Design Principles”, Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, “ Satellite Communication”, Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, “Satellite Communication Systems”, 4th Edition Wiley Publication
5. Gerard Maral, “VSAT Networks”, John Willy & Sons
6. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, “Satellite Communications”, John Willy & Sons (Asia) Pvt. Ltd. 2004
7. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, “Satellite Communication systems Engineering”, Pearson Publication

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8044	Network Management in TeleCommunication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8044	Network Management in TeleCommunication	20	20	20	80	--	--	--	100

Prerequisites:

- Computer Communication and Networks,
- Operating System
- Basic Programming skills

Course objectives:

- To understand the concept of Telecommunication, network management, architecture and protocol

Course outcomes:

After successful completion of the course student will be able to

- Explain the need for interoperable network management & analyze the trends and development of the Telecommunications Network Management.
- Demonstrate broad knowledge of fundamental principles and technical standards underlying.
- Describe the concepts and architecture behind standards based network management associated with SNMP and CMIP.
- Apply basic of telecommunication, networking and information technologies and architect and implement networked informative systems.
- Continuously improve their technology knowledge and communication skills.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Network Management**	**10**
	1.1	Introducing Network Design Concepts: Network designers ensure that our communications networks can adjust and scale to the demands for new services. To support our network-based economy, designers must work to create networks that are available nearly 100 percent of the time. Challenges of IT managers.	
	1.2	Network Management: Goals, organization and functions	
	1.3	Network management architecture and organization network management perspectives	
2.0		**OSI Network Management**	**04**
	2.1	Network management standards	
	2.2	Network management models	
	2.3	Organization model	
	2.4	Information model	
	2.5	Communication model and functional model	
	2.6	Abstract syntax notation – encoding structure, macros functional model CMIP/CMISE	
3.0		**Internet Management**	**12**
	3.1	SNMP-organizational model-	
	3.2	System overview.	
	3.3	Information model, communication model, functional model	
	3.4	SNMP proxy server, Management information, Protocol	
	3.5	SNMPv1,v2 and V3	
	3.6	Remote monitoring. RMON	
4.0		**Telecommunication Management Networks(TMN)**	**04**
	4.1	Need for TMN , Conceptual TNM model	
	4.2	TMN Network Management Architecture	
	4.3	TMN management services architecture and TMN implementation	
5.0		**Network Management Tools and Applications**	**12**
	5.1	System Utilities for network management	
	5.2	Network statistics and measurements	
	5.3	NMS Design, NMS components, NMS Server Architecture	
	5.4	Network Management Systems and FCAPS	
	5.5	Automatic Fault Management and Event correlation Techniques	
	5.6	Security Management	
6.0		**Broadband Network Management**	**06**
	6.1	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN	

	6.2	ATM Network Management – ATM network reference model, integrated local management interface. ATM management management information base, role of SNMP and ILMI in ATM.	
	6.3	M1, M2, M3, M4 interface. ATM digital exchange interface management	
		Total	**48**

Text Books & References :

1. Mani Subramaniam, ―Network Management Principles and Practise", Addison Wisely, New York, 2000.
2. Designing and Supporting Computer Networks, CCNA Discovery Learning Guide By Kenneth Stewart, Aubrey Adams, Allan Reid, Jim Lorenz, Cisco Press
3. Network Management: Concepts and Practice, A Hands-On Approach by J. Richard Burke, Pearson Publications.
4. Network Management: Accounting and Performance Strategies by Benoit Claise - CCIE No. 2686; Ralf Wolter CISCO Press
5. Network Management Fundamentals, Alexander Clemm, Cisco Press, December 2006, ISBN-13: 978-158720137
6. Python for Software Design by Allen B. Downey, Cambridge University Press, March 2009, ISBN-13: 978-0521725965. A free manuscript is available at the author's website.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8021	Project Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8021	Project Management	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course outcomes:

After successful completion of the course student will be able to

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module No.	Unit No.	Topics	Hrs.
1.0		**Project Management Foundation**	**05**
	1.1	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	
2.0		**Initiating Projects**	**06**
	2.1	How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	
3.0		**Project Planning and Scheduling**	**08**
	3.1	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	
4.0		**Planning Projects**	**06**
	4.1	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
5.0			**08**
	5.1	**Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings	
	5.2	**Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit	
	5.3	**Project Contracting** Project procurement management, contracting and outsourcing,	
6.0			**06**
	6.1	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects	

	6.2	**Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
		Total	**39**

References:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8022	Finance Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8022	Finance Management	20	20	20	80	--	--	--	100

Course objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course outcomes:

After successful completion of the course student will be able to

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	Hrs.
1.0			**06**
	1.1	**Overview of Indian Financial System** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
2.0			**06**
	2.1	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	
3.0			**09**
	3.1	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
4.0			**10**
	4.1	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	

5.0			**05**
	5.1	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
6.0			**03**
	6.1	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	
		Total	**39**

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8023	Entrepreneurship Development and Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8023	Entrepreneurship Development and Management	20	20	20	80	--	--	--	100

Course objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module No.	Unit No.	Topics	Hrs.
1.0			**04**
	1.1	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2.0			**09**
	2.1	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	
3.0			**05**
	3.1	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	
4.0			**08**
	4.1	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5.0			**08**
	5.1	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
6.0			**05**
	6.1	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	
		Total	**39**

References:

1. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
2. T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
3. C N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
4. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8024	Human Resource Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8024	Human Resource Management	20	20	20	80	--	--	--	100

Course objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
- To familiarize the students about the latest developments, trends & different aspects of HRM
- To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Course outcomes:

After successful completion of the course student will be able to

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to HR**	**05**
	1.1	Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions	
	1.2	Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	
2.0		**Organizational Behaviour (OB)**	**07**
	2.1	Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues	
	2.2	Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	
	2.3	Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour	
	2.4	Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor)	
	2.5	Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team	
	2.6	Case study	
3.0		**Organizational Structure &Design**	**06**
	3.1	Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	
	3.2	Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	
	3.3	Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
4.0		**Human resource Planning**	**05**
	4.1	Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale	
	4.2	Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning	
	4.3	Training & Development: Identification of Training Needs, Training Methods	
5.0		**Emerging Trends in HR**	**06**

	5.1	Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment	
	5.2	Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	
6.0			**10**
	6.1	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries	
	6.2	**Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	
	6.3	**Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
		Total	**39**

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Internal Assessment:
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End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	20	20	20	80	--	--	--	100

Course objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Course outcomes:

After successful completion of the course student will be able to

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module No.	Unit No.	Topics	Hrs.
1.0			**04**
	1.1	**Professional Ethics and Business :** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
2.0			**08**
	2.1	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
3.0			**06**
	3.1	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
4.0			**05**
	4.1	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	
5.0			**08**
	5.1	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
6.0			**08**
	6.1	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
		Total	**39**

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.

2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8026	Research Methodology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8026	Research Methodology	20	20	20	80	--	--	--	100

Course objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course outcomes:

After successful completion of the course student will be able to

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction and Basic Research Concepts**	**09**
	1.1	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	
	1.2	Need of Research in Business and Social Sciences	
	1.3	Objectives of Research	
	1.4	Issues and Problems in Research	
	1.5	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	
2.0		**Types of Research**	**07**
	2.1	Basic Research	
	2.2	Applied Research	
	2.3	Descriptive Research	
	2.4	Analytical Research	
	2.5	Empirical Research	
	2.6	Qualitative & Quantitative Approaches	
3.0		**Research Design and Sample Design**	**07**
	3.1	Research Design – Meaning, Types and Significance	
	3.2	Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	
4.0		**Research Methodology**	**08**
	4.1	Meaning of Research Methodology	
	4.2	Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
5.0		**Formulating Research Problem**	**04**
	5.1	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	
6.0		**Outcome of Research**	**04**

	6.1	Preparation of the report on conclusion reached	
	6.2	Validity Testing & Ethical Issues	
	6.3	Suggestions and Recommendation	
		Total	**39**

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C. R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd} ed.), Singapore, Pearson Education

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8027	IPR and Patenting	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8027	IPR and Patenting	20	20	20	80	--	--	--	100

Course objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course outcomes:

After successful completion of the course student will be able to

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module No.	Unit No.	Topics	Hrs.
1.0			**05**
	1.1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	
2.0			**07**
	2.1	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	
3.0			**05**
	3.1	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	
4.0			**07**
	4.1	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
5.0			**08**
	5.1	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	
6.0			**07**
	6.1	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	
		Total	**39**

References:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8028	Digital Business Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8028	Digital Business Management	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course outcomes:

After successful completion of the course student will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module No.	Unit No.	Topics	Hrs.
1.0			**09**
	1.1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	
2.0			**06**
	2.1	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	
3.0			**06**
	3.1	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	
4.0			**06**
	4.1	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5.0			**04**
	5.1	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	

6.0			**08**
	6.1	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	
		Total	**39**

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8029	Environmental Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8029	Environmental Management	20	20	20	80	--	--	--	100

Course objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module No.	Unit No.	Topics	Hrs.
1.0			**10**
	1.1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
2.0			**06**
	2.1	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
3.0			**05**
	3.1	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
4.0			**10**
	4.1	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
5.0			**05**
	5.1	Total Quality Environmental Management, ISO-14000, EMS certification	
6.0			**03**
	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
		Total	**39**

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management **V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC

Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	RF Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL801	RF Design Laboratory	--	--	--	--	25	25	--	50

Suggested List of experiments

- Calibration of Network analyser for measurements.
- Characterization of RF low pass filter.
- Characterization of RF high pass filter.
- Characterization of RF band pass filter.
- Design of passive matching networks.
- Stability circles for microwave transistor
- Gain and Noise circles for transistor amplifier design
- Measurement of radiated emission using EMI Probes for DOT.
- Measurement of conducted radiations.
- Grounding & shielding for EMC.
- Testing of various emission standards like MIL CESPARE.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	Wireless Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL801	Wireless Networks Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8041	Optical Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8041	Optical Networks Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 05 Experiments, 02 tutorials and 1 mini project covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	--	--	--	25	25	--	50

Suggested List of Experiments

- Write a program to implement multirate sampling technique for Interpolation.
- Write a program to implement multirate sampling techniques for Decimation.
- Design Anti-aliasing and Anti-Imaging filters.
- Write a program to demonstrate LMS algorithm for noise cancellations.
- Write a program to demonstrate RLS algorithm to calculate it's error function.
- Demonstrate application of Wavelet Transform for denoising.
- Analyse the frequency contents in EEG record.
- Write a program to generate ECG signal and isolate the QRS complex.

Instructions:

1. Minimum 4 experiments and 4 assignments must be submitted by each student.
2. Assignments can be designed on problem based learning from the content of the syllabus.
3. Simulation tools like Matlab/Scilab can be used.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8043	Satellite Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8043	Satellite Communication Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	--	--	--	25	25	--	50

Suggested List of Experiments

- Network Monitoring tools

  a) Status b)Route c)Traffic Tools

- Network Audit using NMAP Gui
- Monitoring and management network using SNMP

  a) Basic SNMP b) Advanced SNMP v3 Authentication/Encryption and ACL

  c) SNMP Trap Daemon Implementation

- Configuration SNMP Protocol on Cisco Router using Packet Tracer
- Install and configure SNMP MIB browser

  a) qtmib b)snmpB c) OpManager MIB browser

- Configuration manageable Switch: Dlink DES 3026 24 Port L2 Switch
- Network Statistics and measurement

a] LAN Traffic Monitoring b) Protocol statistics

- LAN Troubleshooting using Wireshark
- Monitoring of services and Servers using Observium\
- Monitoring of services and Servers using Cacti
- Install and configure NAGIOS and monitor server
- Installation and Configuration of OpenNMS as a NMS.
- Implementation of Centralized Log Management System: Syslog-ng
- Study of commercial network management tools: HPOpenView, OpManager, GFILanguard and IBM NMS.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL803	Project Stage-II	--	12	--	--	6	--	6

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL803	Project Stage-II	--	--	--	--	100	50	--	150

Objective: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the University of Mumbai. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software‘s and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project. Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical:

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-II.

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC801	RF Design	4	-	--	4	--	4
ECC802	Wireless Networks	4	-	-	4	-	4
ECCDLO 804X	Department Level Optional Course IV	4	-	-	4	-	4
ILO802X	Institute Level Optional Course II	3	-	-	3	-	3
ECL801	RF Design Lab	-	2	-	-	1	1
ECL802	Wireless Networks Lab	-	2	-	-	1	1
ECLDLO 804X	Department Level Optional Lab IV	-	2	-	-	1	1
ECL803	Project-II	-	12	-	-	6	6
Total		**15**	**18**	**-**	**15**	**9**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC801	RF Design	20	20	20	80	03	--	--	100
ECC802	Wireless Networks	20	20	20	80	03	--	--	100
ECCDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
ECL801	RF Design Lab	--	--	--	--	--	25	25	50
ECL802	Wireless Networks Lab	--	--	--	--	--	25	25	50
ECLDLO 804X	Department Level Optional Lab IV	--	--	--	--	--	25	25	50
ECL803	Project-II	--	--	--	--	--	100	50	150
Total				**80**	**320**		**175**	**125**	**700**

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ECCDLO8041	Optical Networks	ILO8021	Project Management
ECCDLO8042	Advanced Digital Signal Processing	ILO8022	Finance Management
ECCDLO8043	Satellite Communication	ILO8023	Entrepreneurship Development and Management
ECCDLO8044	Network management in Telecommunication	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

 # Common with all branches

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC801	RF Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC801	RF Design	20	20	20	80	--	--	--	100

Prerequisites:

- Electromagnetic Engineering
- Antenna & Radio Wave Propagation
- Communication Engineering
- Microwave Engineering

Course objectives:

- To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver
- To learn importance of EMI/EMC

Course outcomes:

After successful completion of the course student will be able to

- Design impedance matching networks and passive RF filters.
- Design and appraise RF amplifiers and oscillators.
- Analyze EMI and EMC in RF circuits.

Module No.	Unit No.	Topics	Hrs.
1.0		**RF Filter Design**	**10**
	1.1	Image parameter method	
	1.2	Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation	
2.0		**Amplifier Design**	**08**
	2.1	Two-port power gain stability	
	2.2	Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design	
	2.3	Power amplifier design.: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier	
3.0		**Frequency Generation & Mixer**	**08**
	3.1	One-port and two-port microwave oscillator design.	
	3.2	Analysis of phase noise in oscillators.	
	3.3	Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers.	
4.0		**Frequency Synthesizers**	**06**
	4.1	Direct Frequency Synthesis, Frequency Synthesis by Phase Lock, Effects of Reference Frequency on Loop Performance,	
	4.2	Variable-Modulus Dividers, Down Conversion, Methods for Reducing Switching Time, Direct Digital Synthesis, Synthesizer Design .	
	4.3	Phase Noise: A Model for Oscillator Phase Noise, Phase Noise in Phase-Locked Loops, Effect of Frequency Division and Multiplication on Phase Noise.	
5.0		**Electromagnetic Interference in RF circuits**	**08**
	5.1	Introduction. Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. **Quantification Of Communication System EMI**	
	5.2	Elements Of Interference, Including Antennas, Transmitters, Receivers And Propagation. **Electronic Equipment And System EMI Concepts.** Examples Of EMI Coupling Modes	
	5.3	**Equipment Emissions And Susceptibilities- Types of coupling: Common-Mode Coupling:** Common-Mode Coupling Mechanisms Including Field To Cable, Ground Impedance, Ground Loop And Coupling Reduction Techniques **Differential-Mode Coupling** : Differential-Mode Coupling Mechanisms Including Field To Cable, Cable To Cable And Coupling Reduction Techniques.	
	5.4	**Other Coupling mechanisms:** Power Supplies And Victim Amplifiers	

6.0		**Electromagnetic Compatibility**	**08**
	6.1	**The Importance Of Grounding For Achieving EMC.** Grounding, Including The Reasons (I.E., Safety, Lightning Control, EMC, Grounding Schemes (Single Point, Multi-Point And Hybrid), Shield Grounding And Bonding. Shielding Effectiveness, Shielding Considerations (Reflective And Absorptive), Shielding Compromises (I.E., Apertures, Gaskets, Waveguide Beyond Cut-Off)	
	6.2	**EMI Diagnostics And Fixes:** Techniques Used In EMI Diagnostics And Fixes	
	6.3	**EMC Specifications, Standards And Measurements.** A Discussion Of The Genesis Of EMC Documentation Including A Historical Summary, The Rationale, And A Review Of MIL-Stds, FCC And CISPR Requirements.	
		Total	**48**

Text Books

1. David M Pozar, Microwave Engineering, John Wiely and Sons, 2005
2. Ludwig R. and Bogdanov G, RF Circuit Design, Prentice Hall, 2007.
3. Jack Smith, Modern Communication circuits,Tata McgrawHill.
4. W. Prasad Kodali, Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models, 2nd Edition, ISBN: 978-0-7803-4743-4, January 2001, Wiley-IEEE Press
5. David. A. Weston, Electromagnetic Compatibility-principles and applications, Second Edition, Publisher: Marcel Dekker, Inc. 2001, ISBN 0-8247-8889-3

References:

1. Guillermo Gonzalez, 'Microwave Transistor Amplifiers Analysis and Design', Prentice Hall, 2nd Edition.
2. Devendra Misra, 'Radio Frequency and Microwave Communication Circuits-Analysis and Design', John Wiley & Sons, 2nd Edition.
3. Clayton R. Paul, 'Electromagnetic Compatibility', John Wiley & Sons, 2nd Edition.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC802	Wireless Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC802	Wireless Networks	20	20	20	80	--	--	--	100

Prerequisites:

- Mobile Communication

Course objectives:

- Introduction to wireless Body Networks and study emerging technologies like Bluetooth and Zigbee
- To study Wireless LAN, PAN & MAN.
- Understanding Ultra Wideband communication.
- Introduction to Femtocells

Course outcomes:

After successful completion of the course student will be able to

- Explain the working of different wireless technologies like bluetooth and zigbee.
- Understand the working of wireless LAN, PAN & MAN
- Analyze the different types of Wireless Networks like LAN,PAN & MAN
- Comprehend the working of Femtocells.

Module No.	Unit No.	Topics	Hrs.
1.0		**Wireless Body Area Networks**	**12**
	1.1	Introduction to WBAN, Network Architecture, Network Components	
	1.2	Network Protocol: Physical Layer, Data Link layer, Media Access Control (MAC) Layer, Network Layer	
	1.3	**WBAN Technologies:** Bluetooth: Concept of Piconet, Scatternet, Protocol Stack Connection establishment **Zigbee:** Components, Protocol Stack, Architecture & Network Topologies	
2.0		**Wireless LAN**	**10**
	2.1	Introduction to wireless LAN, Transmission Techniques	
	2.2	Medium Access Control Protocol Issues: Hidden Terminal Problem, Reliability, Collision Avoidance, Congestion Avoidance, Congestion Control, Energy Efficiency	
	2.3	IEEE 802.11 Standard for Wireless LAN: Network Architecture, Physical Layer, MAC Layer, Security, System design and considerations	
	2.4	Enhancements to IEEE 802.11 MAC: Power Control, Spatial Reusability & QoS Provisioning	
3.0		**Wireless PAN**	**08**
	3.1	Introduction to wireless PAN, Need of Wireless PAN	
	3.2	Bluetooth Technology: History & Applications, Technical Overview, Bluetooth Specifications, Piconet Synchronization, master-slave switch, Bluetooth security.	
	3.3	Enhancements to Bluetooth: Bluetooth Interface issues, Intra & Inter Piconet Scheduling, Scatternet Formation, QoS Assignment	
	3.4	IEEE 802.15 Working group for WPAN, IEEE 802.15.3 & IEEE 802.15.4	
	3.5	Comparison between WPAN System & Comparison between WLAN & WPAN	
4.0		**Wireless MAN**	**08**
	4.1	Introduction to Wireless Metropolitan Area Networks, IEEE 802.16 Standards Advantages of IEEE 802.16	
	4.2	WMAN Network Architecture: Network Components, features of WiMAX, WiMAX Mobility Support	
	4.3	Network Protocols : Physical Layer, MAC Layer	
		WMAN Applications: Banking Networks, Educational Networks, Public Safety	
5.0		**Ultra wideband Communication**	**06**
	5.1	Introduction, UWB indoor channel, UWB capacity	

	5.2	Pulsed UWB: Pulse shape, Modulation & Multiple access techniques, Pulsed UWB transceivers,	
	5.3	Multiband UWB: Modulation of pulsed multiband UWB, MB-OFDM UWB	
6.0		**Femtocells**	**04**
	6.1	Introduction to Femtocell, Femtocell Attributes, Femtocell Standards,	
	6.2	Concept of Femtocells, Types of Femtocells	
	6.3	Applications of Femtocells.	
		Total	

Text Books & References :

1. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, "AD HOC & Sensor Networks – Theory & Applications ", Cambridge University Press India Pvt. Ltd.
2. KE- LIN DU & M. N. S. Swamy, "Wireless Communication Systems", Cambridge University Press India Pvt. Ltd.
3. D. E. Comer, "Femtocells- Opportunity & Challenges for Business & Technology", Wiley Publications.
4. Dr. Sunilkumar S. Manvi, Mahabaleshwar S. kakkasageri, "Wireless & Mobile Networks: Concepts and Protocols".

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8041	Optical Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8041	Optical Networks	20	20	20	80	--	--	--	100

Prerequisites:

- Principles of Communication Engineering
- Digital Communication
- Antenna Wave Propagation
- Optical Communication

Course objectives:

- The issues related to signal degradation due to linear impairment
- High data rate WDM optical transport networks
- Link budget and optical networks, design and management.

Course outcomes:

After successful completion of the course student will be able to

- Identify the issues related to signal degradation and multiplexing.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.
- Apply the knowledge developed in-class to contemporary optical fiber communication research and industrial areas.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Optical Components and Networks**	**06**
	1.1	OPTICAL Components - Couplers, Isolators and Circulators, Multiplexes and Filters Optical Amplifiers. Transmitters, Detectors, Switches, Wavelength Converters	
	1.2	OPTICAL Networks - Telecommunication networks, First generation optical networks, Multiplexing techniques, Second generation optical networks, System and network evolution	
2.0		**Optical Networks Architecture**	**08**
	2.1	SONET/SDH, Computer interconnects, MANS, Layered architecture for SONET and second generation networks.	
	2.2	Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols,	
	2.3	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons	
3.0		**Packet Switching and Access Networks**	**08**
	3.1	Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing,	
	3.2	Synchronization, Broadcast OTDM networks, Switch-based networks	
	3.3	Access Networks – Network Architecture overview, Future Access Networks,	
	3.4	Optical Access Networks Architectures; and OTDM networks	
4.0		**Wavelength Routing Networks**	**10**
	4.1	Optical layer, Node design, Network design and operation, routing and wavelength assignment architectural variations	
	4.2	Optical Network Routing Principles - Impairment Aware Routing Optical Circuit Switching ,Optical Packet Switching Optical Burst Switching	
	4.3	Energy Awareness in Optical Networking ,Network Modeling Tools Network Design Guidelines	
5.0		**Design of Optical Networks**	**10**
	5.1	Core Optical Networks, Metro Optical networks, Access Optical Networks	
	5.2	Wavelength Routing and Assignment, Traffic Grooming and Protection, Multilayer Network Structure	
	5.3	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization	
6.0		**Virtual topology, Network Control and Management**	**06**
	6.1	Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies,	

	6.2	Control and management, Network management configuration management, Performance management, fault management. Network management functions, Optical safety	
		Total	**48**

Text Books :

1. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Optical Networks: A Practical Perspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
2. Harry G. Parros, Communication Oriented Networks, Wiley
3. G. Agrwal, Fiber Optic Communication Systems, John Wiley and Sons, 3rd Edition, New York, 2014.

References:

1. C. Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice Hall of India, 1st Edition, 2002.
2. Biswajit Mukherjee, Optical Communication Networks, TMG1998.
3. Jane M. Simoons, Optical Network Design and Planning, Second Edition, Springer
4. Ulysees Black, Optical Networks, Pearson education 2007.
5. Milorad Cvijetic, Ivan B. Djordjevic, Advanced Optical Communication Systems and Networks, Artech House Applied Photonics, 2012.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8042	Advanced Digital Signal Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8042	Advanced Digital Signal Processing	20	20	20	80	--	--	--	100

Prerequisites:

- Discrete Time Signal Processing

Course objectives:

The aim of this course is to provide in-depth treatment on methods and techniques on

- Multirate Signal Processing, Power Spectrum Estimation, Adaptive Filtering and Wavelet Transform.
- Application of signal processing to real world problems.

Course outcomes:

After successful completion of the course student will be able to

- Demonstrate an understanding of multirate sampling and its mechanism.
- Study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
- Implement adaptive filters for given applications.
- Apply signal processing tools to Biomedical and Telecommunication Applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Multirate Digital Signal Processing**	**08**
	1.1	Advantages of Multirate Signal Processing	
	1.2	Interpolation and Decimation	
	1.3	Sampling Rate Conversion by Non Integer Factor	
	1.4	Multistage Interpolation and Decimation	
	1.5	Polyphase Decomposition	
	1.6	Digital Filter Banks	
	1.7	Applications of Multirate Signal Processing	
2.0		**Power Spectrum Estimation**	**10**
	2.1	**Non Parametric Method of Power Spectrum Estimation:** Periodogram, Modified Periodogram, Barlett Method, Welch's Method, Blackman-Tukey Approach	
	2.2	**Parametric Methods of Power Spectrum Estimation:** Auto Regressive Spectrum Estimation, Model Parameters-Yule-Walker Equation, Least Square Method and Linear Prediction, Moving Average Spectrum Estimation, Autoregressive Moving Average Spectrum Estimation	
	2.3	Eigen Analysis Algorithm for Spectrum Estimation	
3.0		**Linear Prediction and Optimum Linear Filters**	**10**
	3.1	Representation of Stationary Random Process	
	3.2	Forward and Backward Linear Prediction	
	3.3	Solution of Normal Equation(Levinson-Durbin and Schur Algorithm)	
	3.4	AR Lattice and ARMA Lattice Ladder Filters	
	3.5	Weiner Filters for Filtering and Prediction	
4.0		**Adaptive Filters**	**10**
	4.1	**Applications of Adaptive Filters:** System Identification, Adaptive Channel Equalization, Echo Cancellation, Adaptive Noise Cancellation, Suppression of Narrowband Interference in Wideband Signals, Adaptive Arrays.	
	4.2	**Adaptive Algorithms:** LMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm	
5.0		**Wavelet Transform**	**06**
	5.1	Introduction to Time Frequency Analysis	
	5.2	Short Time Fourier Transform	
	5.3	Continuous Wavelet Transform	
	5.4	Discrete Wavelet Transform	
	5.5	Multiresolution Analysis	

	5.6	Applications	
6.0		**Application Of Signal Processing**	**04**
	6.1	Biomedical Applications	
	6.2	Audio Applications	
	6.3	Telecommunication Applications(Radar)	
		Total	**48**

Textbooks

1. John G. Proakis, Dimitris G. Monolakis " Digital Signal Processing", PHI 2007.
2. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing A Practical Approach", Pearson Education 2008.

Reference Books

1. Simon Haykin, "Adaptive Filter Theory", Pearson Education 2013.
2. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press.
3. Raghuveer M. Rao and Ajit S. Bopardikar, "Wavelet Transforms", "Introduction to Theory and Applications", Pearson Education Asia 2000.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8043	Satellite Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8043	Satellite Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication
- Digital Communication

Course objectives:

- To understand the basics of satellite communications and different satellite communication orbits
- Provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology
- To explain the tools necessary for the calculation of basic parameters in a satellite communication system.
- Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite

Course outcomes:

After successful completion of the course student will be able to

- Explain basics of satellite communication, space segment and earth segment
- Understand different satellite orbits and orbital parameters
- Explain and analyze link budget of satellite signal for proper communication
- Understand various applications of satellite communications

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of Satellite Systems, Orbits and Launching**	**09**
	1.1	An overview of space and satellite, Frequency allocation for satellite communication, Polar orbiting satellites, Kepler's First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations, effects of a non-spherical earth, atmospheric drag	
	1.2	Wave Propagation & Polarization, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other impairments, Antenna Polarization, Polarization of Satellite signals, Cross polarization discrimination, Ionospheric depolarization, Rain depolarization, Ice depolarization	
	1.3	Sub-satellite Point, predicting satellite position, antenna look angels, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage	
	1.4	Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, launch vehicles; satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	
2.0		**Space Segment**	**06**
	2.1	Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system, reliability and quality Assurance.	
3.0		**Earth station**	**05**
	3.1	Design consideration	
	3.2	General configuration- Block diagram, Receive only type earth, transmit-receive type earth station, Antenna system, Feed system, Tracking system, LNA, HPA	
4.0		**Satellite Links**	**10**
	4.1	Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget	
	4.2	System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature, carrier to noise ratio	
	4.3	Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output	
	4.4	Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, inter-modulation noise	
5.0		**The Space Segment Access and Utilization**	**08**
	5.1	Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	

	5.2	TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA	
	5.3	Code Division Multiple Access: Direct-sequence spread spectrum–acquisition and tracking, spectrum spreading and dispreading – CDMA throughput	
6.0		**Satellite Applications**	**10**
	6.1	VSAT systems: Advantages, configurations, frequency bands, elements, Applications	
	6.2	Broadcast services: Television broadcast systems, DAB,	
	6.3	Mobile satellite communication: INMARSAT, LMSS, mobile satellite systems with non GEO satellites	
	6.4	Satellite navigation systems	
	6.5	Laser Satellite Communication: Link analysis, optical satellite link transmitter, optical satellite link receiver, satellite beam acquisition, tracking & positioning, deep space optical communication link	
	6.6	Recent applications	
	6.7	Modern development and future trends	
		Total	**48**

Text Books & References :

1. Dennis Roddy, “Satellite Communications”, 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, “Satellite Communication Systems Design Principles”, Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, “ Satellite Communication”, Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, “Satellite Communication Systems”, 4th Edition Wiley Publication
5. Gerard Maral, “VSAT Networks”, John Willy & Sons
6. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, “Satellite Communications”, John Willy & Sons (Asia) Pvt. Ltd. 2004
7. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, “Satellite Communication systems Engineering”, Pearson Publication

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8044	Network Management in TeleCommunication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8044	Network Management in TeleCommunication	20	20	20	80	--	--	--	100

Prerequisites:

- Computer Communication and Networks,
- Operating System
- Basic Programming skills

Course objectives:

- To understand the concept of Telecommunication, network management, architecture and protocol

Course outcomes:

After successful completion of the course student will be able to

- Explain the need for interoperable network management & analyze the trends and development of the Telecommunications Network Management.
- Demonstrate broad knowledge of fundamental principles and technical standards underlying.
- Describe the concepts and architecture behind standards based network management associated with SNMP and CMIP.
- Apply basic of telecommunication, networking and information technologies and architect and implement networked informative systems.
- Continuously improve their technology knowledge and communication skills.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Network Management**	**10**
	1.1	Introducing Network Design Concepts: Network designers ensure that our communications networks can adjust and scale to the demands for new services. To support our network-based economy, designers must work to create networks that are available nearly 100 percent of the time. Challenges of IT managers.	
	1.2	Network Management: Goals, organization and functions	
	1.3	Network management architecture and organization network management perspectives	
2.0		**OSI Network Management**	**04**
	2.1	Network management standards	
	2.2	Network management models	
	2.3	Organization model	
	2.4	Information model	
	2.5	Communication model and functional model	
	2.6	Abstract syntax notation – encoding structure, macros functional model CMIP/CMISE	
3.0		**Internet Management**	**12**
	3.1	SNMP-organizational model-	
	3.2	System overview.	
	3.3	Information model, communication model, functional model	
	3.4	SNMP proxy server, Management information, Protocol	
	3.5	SNMPv1,v2 and V3	
	3.6	Remote monitoring. RMON	
4.0		**Telecommunication Management Networks(TMN)**	**04**
	4.1	Need for TMN , Conceptual TNM model	
	4.2	TMN Network Management Architecture	
	4.3	TMN management services architecture and TMN implementation	
5.0		**Network Management Tools and Applications**	**12**
	5.1	System Utilities for network management	
	5.2	Network statistics and measurements	
	5.3	NMS Design, NMS components, NMS Server Architecture	
	5.4	Network Management Systems and FCAPS	
	5.5	Automatic Fault Management and Event correlation Techniques	
	5.6	Security Management	
6.0		**Broadband Network Management**	**06**
	6.1	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN	

	6.2	ATM Network Management – ATM network reference model, integrated local management interface. ATM management management information base, role of SNMP and ILMI in ATM.	
	6.3	M1, M2, M3, M4 interface. ATM digital exchange interface management	
		Total	**48**

Text Books & References :

1. Mani Subramaniam, ―Network Management Principles and Practise", Addison Wisely, New York, 2000.
2. Designing and Supporting Computer Networks, CCNA Discovery Learning Guide By Kenneth Stewart, Aubrey Adams, Allan Reid, Jim Lorenz, Cisco Press
3. Network Management: Concepts and Practice, A Hands-On Approach by J. Richard Burke, Pearson Publications.
4. Network Management: Accounting and Performance Strategies by Benoit Claise - CCIE No. 2686; Ralf Wolter CISCO Press
5. Network Management Fundamentals, Alexander Clemm, Cisco Press, December 2006, ISBN-13: 978-158720137
6. Python for Software Design by Allen B. Downey, Cambridge University Press, March 2009, ISBN-13: 978-0521725965. A free manuscript is available at the author's website.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8021	Project Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8021	Project Management	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course outcomes:

After successful completion of the course student will be able to

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module No.	Unit No.	Topics	Hrs.
1.0		**Project Management Foundation**	**05**
	1.1	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	
2.0		**Initiating Projects**	**06**
	2.1	How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	
3.0		**Project Planning and Scheduling**	**08**
	3.1	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	
4.0		**Planning Projects**	**06**
	4.1	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
5.0			**08**
	5.1	**Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings	
	5.2	**Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit	
	5.3	**Project Contracting** Project procurement management, contracting and outsourcing,	
6.0			**06**
	6.1	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects	

	6.2	**Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
		Total	**39**

References:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8022	Finance Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8022	Finance Management	20	20	20	80	--	--	--	100

Course objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course outcomes:

After successful completion of the course student will be able to

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	Hrs.
1.0			**06**
	1.1	**Overview of Indian Financial System** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
2.0			**06**
	2.1	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	
3.0			**09**
	3.1	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
4.0			**10**
	4.1	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	

5.0			**05**
	5.1	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
6.0			**03**
	6.1	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	
		Total	**39**

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8023	Entrepreneurship Development and Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8023	Entrepreneurship Development and Management	20	20	20	80	--	--	--	100

Course objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module No.	Unit No.	Topics	Hrs.
1.0			**04**
	1.1	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2.0			**09**
	2.1	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	
3.0			**05**
	3.1	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	
4.0			**08**
	4.1	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5.0			**08**
	5.1	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
6.0			**05**
	6.1	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	
		Total	**39**

References:

1. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
2. T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
3. C N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
4. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8024	Human Resource Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8024	Human Resource Management	20	20	20	80	--	--	--	100

Course objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
- To familiarize the students about the latest developments, trends & different aspects of HRM
- To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Course outcomes:

After successful completion of the course student will be able to

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to HR**	**05**
	1.1	Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions	
	1.2	Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	
2.0		**Organizational Behaviour (OB)**	**07**
	2.1	Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues	
	2.2	Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	
	2.3	Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour	
	2.4	Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor)	
	2.5	Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team	
	2.6	Case study	
3.0		**Organizational Structure &Design**	**06**
	3.1	Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	
	3.2	Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	
	3.3	Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
4.0		**Human resource Planning**	**05**
	4.1	Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale	
	4.2	Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning	
	4.3	Training & Development: Identification of Training Needs, Training Methods	
5.0		**Emerging Trends in HR**	**06**

	5.1	Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment	
	5.2	Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	
6.0			**10**
	6.1	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries	
	6.2	**Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	
	6.3	**Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
		Total	**39**

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	20	20	20	80	--	--	--	100

Course objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Course outcomes:

After successful completion of the course student will be able to

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module No.	Unit No.	Topics	Hrs.
1.0			**04**
	1.1	**Professional Ethics and Business :** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
2.0			**08**
	2.1	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
3.0			**06**
	3.1	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
4.0			**05**
	4.1	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	
5.0			**08**
	5.1	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
6.0			**08**
	6.1	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
		Total	**39**

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.

2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8026	Research Methodology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8026	Research Methodology	20	20	20	80	--	--	--	100

Course objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course outcomes:

After successful completion of the course student will be able to

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction and Basic Research Concepts**	**09**
	1.1	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	
	1.2	Need of Research in Business and Social Sciences	
	1.3	Objectives of Research	
	1.4	Issues and Problems in Research	
	1.5	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	
2.0		**Types of Research**	**07**
	2.1	Basic Research	
	2.2	Applied Research	
	2.3	Descriptive Research	
	2.4	Analytical Research	
	2.5	Empirical Research	
	2.6	Qualitative & Quantitative Approaches	
3.0		**Research Design and Sample Design**	**07**
	3.1	Research Design – Meaning, Types and Significance	
	3.2	Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	
4.0		**Research Methodology**	**08**
	4.1	Meaning of Research Methodology	
	4.2	Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
5.0		**Formulating Research Problem**	**04**
	5.1	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	
6.0		**Outcome of Research**	**04**

	6.1	Preparation of the report on conclusion reached	
	6.2	Validity Testing & Ethical Issues	
	6.3	Suggestions and Recommendation	
		Total	**39**

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C. R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd} ed.), Singapore, Pearson Education

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8027	IPR and Patenting	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8027	IPR and Patenting	20	20	20	80	--	--	--	100

Course objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course outcomes:

After successful completion of the course student will be able to

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module No.	Unit No.	Topics	Hrs.
1.0			**05**
	1.1	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	
2.0			**07**
	2.1	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	
3.0			**05**
	3.1	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	
4.0			**07**
	4.1	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
5.0			**08**
	5.1	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	
6.0			**07**
	6.1	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	
		Total	**39**

References:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8028	Digital Business Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8028	Digital Business Management	20	20	20	80	--	--	--	100

Course objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course outcomes:

After successful completion of the course student will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module No.	Unit No.	Topics	Hrs.
1.0			**09**
	1.1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	
2.0			**06**
	2.1	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	
3.0			**06**
	3.1	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	
4.0			**06**
	4.1	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5.0			**04**
	5.1	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	

6.0			**08**
	6.1	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	
		Total	**39**

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8029	Environmental Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8029	Environmental Management	20	20	20	80	--	--	--	100

Course objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module No.	Unit No.	Topics	Hrs.
1.0			**10**
	1.1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
2.0			**06**
	2.1	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
3.0			**05**
	3.1	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
4.0			**10**
	4.1	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
5.0			**05**
	5.1	Total Quality Environmental Management, ISO-14000, EMS certification	
6.0			**03**
	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
		Total	**39**

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management **V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC

Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	RF Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL801	RF Design Laboratory	--	--	--	--	25	25	--	50

Suggested List of experiments

- Calibration of Network analyser for measurements.
- Characterization of RF low pass filter.
- Characterization of RF high pass filter.
- Characterization of RF band pass filter.
- Design of passive matching networks.
- Stability circles for microwave transistor
- Gain and Noise circles for transistor amplifier design
- Measurement of radiated emission using EMI Probes for DOT.
- Measurement of conducted radiations.
- Grounding & shielding for EMC.
- Testing of various emission standards like MIL CESPARE.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	Wireless Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL801	Wireless Networks Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8041	Optical Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8041	Optical Networks Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 05 Experiments, 02 tutorials and 1 mini project covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	--	--	--	25	25	--	50

Suggested List of Experiments

- Write a program to implement multirate sampling technique for Interpolation.
- Write a program to implement multirate sampling techniques for Decimation.
- Design Anti-aliasing and Anti-Imaging filters.
- Write a program to demonstrate LMS algorithm for noise cancellations.
- Write a program to demonstrate RLS algorithm to calculate it's error function.
- Demonstrate application of Wavelet Transform for denoising.
- Analyse the frequency contents in EEG record.
- Write a program to generate ECG signal and isolate the QRS complex.

Instructions:

1. Minimum 4 experiments and 4 assignments must be submitted by each student.
2. Assignments can be designed on problem based learning from the content of the syllabus.
3. Simulation tools like Matlab/Scilab can be used.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8043	Satellite Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8043	Satellite Communication Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	--	--	--	25	25	--	50

Suggested List of Experiments

- Network Monitoring tools

  a) Status b)Route c)Traffic Tools

- Network Audit using NMAP Gui
- Monitoring and management network using SNMP

  a) Basic SNMP b) Advanced SNMP v3 Authentication/Encryption and ACL

  c) SNMP Trap Daemon Implementation

- Configuration SNMP Protocol on Cisco Router using Packet Tracer
- Install and configure SNMP MIB browser

  a) qtmib b)snmpB c) OpManager MIB browser

- Configuration manageable Switch: Dlink DES 3026 24 Port L2 Switch
- Network Statistics and measurement

a] LAN Traffic Monitoring b) Protocol statistics

- LAN Troubleshooting using Wireshark
- Monitoring of services and Servers using Observium\
- Monitoring of services and Servers using Cacti
- Install and configure NAGIOS and monitor server
- Installation and Configuration of OpenNMS as a NMS.
- Implementation of Centralized Log Management System: Syslog-ng
- Study of commercial network management tools: HPOpenView, OpManager, GFILanguard and IBM NMS.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL803	Project Stage-II	--	12	--	--	6	--	6

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL803	Project Stage-II	--	--	--	--	100	50	--	150

Objective: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the University of Mumbai. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software‘s and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project. Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical:

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-II.

AC-
Item No.

UNIVERSITY OF MUMBAI

Revised Syllabus for the

Master of Engineering (M.E.) Electronics and Telecommunication Engineering

(As per Choice Based Credit & Grading System with effect from the academic year 2016–2017)

From Co-ordinator's Desk:-

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education, since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System will be implemented for First year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.
2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.
3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.
4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar
Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

Program Structure for M.E. (Electronics & Telecommunication)

(w.e.f. A.Y. 2016-2017) Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC101	Statistical Signal Processing	04	--	--	04	--	--	04
ETC102	Optical Communication Network	04	--	--	04	--	--	04
ETC103	Modern Digital Signal Processing Applications	04	--	--	04	--	--	04
ETDLO1	Department Level Optional Course-1	04	--	--	04	--	--	04
ILO1	Institute Level Optional Course-1	03	--	--	03	--	--	03
ETL101	Laboratory I - Optical Communication Network	--	02	--	--	01	--	01
ETL102	Laboratory II - Modern Digital Signal Processing Applications	--	02	--	--	01	--	01
Total		**19**	**04**	**--**	**19**	**02**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
ETC101	Statistical Signal Processing	20	20	20	80	03	--	--	100
ETC102	Optical Communication Network	20	20	20	80	03	--	--	100
ETC103	Modern Digital Signal Processing Applications	20	20	20	80	03	--	--	100
ETDLO1	Department Level Optional Course-I	20	20	20	80	03	--	--	100
ILO1	Institute Level Optional Course-I	20	20	20	80	03	--	--	100
ETL101	Laboratory I - Optical Communication Network	--	--	--	--	--	25	25	50
ETL102	Laboratory II –Modern Digital Signal Processing Applications	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	50	**50**	**600**

Subject Code ETDLO1	Department Level Optional Course 1
ETDLO1011	Next Generation Networks
ETDLO1012	Advanced Antenna Design
ETDLO1013	Image Analysis using Machine learning
ETDLO1014	Embedded Communication Systems Design

Subject Code ILO1	Institute Level Optional Course1
ILO1011	Product Life cycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management & Mitigation Measures
ILO1018	Energy Audit and Management

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC201	Modern Digital Communication	04	--	--	04	--	--	04
ETC202	Wireless Adhoc and Sensor Networks	04	--	--	04	--	--	04
ETC203	RF and Microwave Engineering	04	--	--	04	--	--	04
ETDLO2	Department Level Optional Course 2	04	--	--	04	--	--	04
ILO2	Institute Level Optional Course 2	03	--	--	03	--	--	03
ETL201	Laboratory III – Wireless Adhoc and Sensor Networks	--	02	--	--	01	--	01
ETL202	Laboratory IV – RF and Microwave Engineering	--	02	--	--	01		01
Total		**19**	**04**	**--**	**19**	**02**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem.Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
ETC201	Modern Digital Communications	20	20	20	80	03	--	--	100
ETC202	Wireless Adhoc and Sensor Networks	20	20	20	80	03	--	--	100
ETC203	RF and Microwave and Engineering	20	20	20	80	03	--	--	100
ETDLO2	Department Level Optional Course 2	20	20	20	80	03	--	--	100
ILO2	Institute Level Optional Course- II	20	20	20	80	03	--	--	100
ETL201	Laboratory III - Wireless Adhoc and Sensor Networks	--	--	--	--	--	25	25	50
ETL202	Laboratory IV - RF and Microwave Engineering	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	--	**50**	**50**	**600**

Subject Code ETDLO2	Department Level Optional Course 2
ETDLO2021	Satellite Networking
ETDLO2022	Network and Cyber Security
ETDLO2023	Remote Sensing
ETDLO2024	Error Control Coding

Subject Code ILO2	Institute Level Optional Course 2
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and CSR
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETS301	Special Topic Seminar	--	06	--	--	03	--	03
ETD301	Dissertation I	--	24	--	--	12	--	12
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem.Exam.			
		Test1	Test 2	Avg.				
ETS301	Special Topic Seminar	--	--	--	--	50	50	100
ETD301	Dissertation I	--	--	--	--	100	--	100
Total		--	--	--	--	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETD401	Dissertation II	--	30	--	--	15	--	15
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem.Exam.			
		Test1	Test 2	Avg.				
ETD401	Dissertation II	--	--	--	--	100	100	200
Total		--	--	--	--	**100**	**100**	**200**

Note:

- In case of Seminar (ETS301), 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I (ETD301) and Dissertation II (ETD401), 02 Hour / week / student should be considered for the calculation of load of a teacher

Subject Code	Subject Name	Credits
ETC101	**Statistical Signal Processing**	**04**

Course Pre-requisite:

- Matrix theory
- Fundamentals of probability
- Signals and systems

Course Objectives:

The aim of this course is to provide knowledge of statistical techniques necessary to explain and explore the important applications in signal processing and telecommunication.

Course Outcome:

Learner will be able to:

- Understand basics of linear algebra in communication engineering.
- Apply appropriate statistical tools for handling design and analysis of systems that involve randomness.
- Analyze random processes for LTI systems and estimation theory.
- Evaluate role of probability models in engineering design.

Module	Detailed Content	Hours
1	**Linear Algebra** • Signal spaces, metric spaces, vector spaces, norms and normed vector spaces, inner-product spaces, orthogonality, orthogonal subspaces, linear transformations: range and null space, orthogonalization of vectors, representation and approximation in vector spaces, matrix representation of least squares, geometry of linear equations, four fundamental subspaces of linear operator, properties of matrix inverses, results on matrix rank, pseudo inverses, matrix condition number, singular value decomposition(SVD), pseudoinverse and the SVD.	12
2	**Review of Random Variables and Processes** • Random variables, distribution and density function, functions of random variables, sums of independent random variables, central limit theorem, discrete time stochastic process, stationarity, random signal variability, time averages, ergodicity, autocorrelation function of a real WSS process and its properties, cross-correlation function, frequency domain description of stationary process, general correlation matrices, correlation matrices from random process, correlation matrices of stationary process.	08
3	**Analysis and processing of random signals** • Linear time invariant system with WSS process as an input:	04

	stationarity of the output, auto-correlation and power-spectral density of the output; examples with white-noise as input; linear shift-invariant discrete-time system with WSS sequence as input, examples of random processes: white noise process and white noise sequence; Gaussian process.	
4	**Whitening and Innovations Representation** • Transformations using eigen-decomposition, transformations using triangular decomposition, generation of real valued random vectors with given second-order moments, discrete Karhunen-Loève transform and its application, optimal reduced-basis representation, periodic random sequences.	08
5	**Principles of Estimation Theory** • Estimation in signal processing, the mathematical estimation problem, assessing estimator performance, unbiased and consistent estimators, confidence interval, efficient estimator, minimum variance unbiased estimation, existence of minimum variance unbiased estimator, estimator accuracy considerations, Cramer-Rao lower bound(CRLB) theorem, computation of CRLB for different examples, general CRLB for signals in white-Gaussian noise, vector parameter CRLB.	10
6	**The Kalman Filter** • The state space signal model, Kalman filter I: The Bayes approach, Kalman filter II: innovations approach, Estimation using the innovations process, innovations for processes with state space models. Discrete-time Kalman filter.	06

Textbooks and References:

1. Todd K. Moon and Wynn C. Stirling, "*Mathematical Methods and Algorithms for Signal Processing*", Pearson Education, Inc., 2000.
2. Dimitris. G. Manolakis, Vinay Ingale, and Stephen M. Kogon, "*Statistical and Adaptive Signal Processing*", Artech House, Inc., 2005.
3. Peyton Z. Peebles, "*Probability, Random Variables and Random Signal Principles*", Mc-Graw Hill, 2000.
4. Steven M. Kay, "*Fundamentals of Statistical Signal Processing: Estimation Theory* Vol 1, Prentice Hall, Englewood Cliffs, NJ, 2010.
5. Alberto Leon-Garcia, "*Probability and Random Processes for Electrical Engineering*", Pearson Education, 2007.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC102	**Optical Communication Network**	**04**

Course Pre-requisite:

- Wave theory and Propagation
- Analog Communication
- Digital Communication

Course Objectives:

To teach students:

- The issues related to signal degradation due to Linear Impairments
- System impairments due to nonlinear effect in fiber.
- System optimization by controlling dispersion and Nonlinear Effects.
- High data rate WDM optical Transport Networks.

Course Outcome:

The course enables the students to:

- Apply the fundamental principles of optics and light wave to design optical fiber communication systems.
- Identify the issues related to signal degradation due to multiplexing.
- Identify working principle of various components of all optical network.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.

Module	Detailed Content	Hours
1	**A Review of Optical Fibers** • Introduction • Signal Degradation • Fiber dispersion • Multimode fiber • Single mode fiber • Dispersion Management • Dispersion compensating Fibers	06
2	**Non Linear Optics** • General Overview of Nonlinearities • Effective area and length • Stimulated Raman Scattering • Stimulated Brillouin Scattering • Self Phase modulation	12

	• Cross –Phase modulation • Four wave mixing and its mitigation • Applications of Nonlinear Effects • Solitons properties of Solitons, Properties of Solitons, Loss managed Soliton ,Dispersion managed Soliton, Optical Switching, Parametric amplification	
3	**Optical Network Components** • Sources: Quantum well lasers, Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers • Detectors: Resonant cavity enhancement (RCE) Photo Detector, Material requirement for RCEPD, Wavelength selectivity, High speed comparison of conventional and RCEPD, RCE Schottky Photodiode, RCE Avalanche Photodiode • Optical Amplifiers: Optical Pumping, Erbium Doped Amplifier, Semiconductor Laser Amplifier, Raman Amplifier, • Integrated Optics: Directional couplers and Photonic Switch, Optical Modulators • WDM network components: WADM, Optical Crossconnects	12
4	**Introduction to Optical Network** • Overview of generations of optical Networks • SONET& SDH: Multiplexing hierarchy, Multiplexing structure – Functional components, Problem detection, Virtual tributaries & containers • Optical Transport Network: Hierarchy, Frame structure, Multiplexing	06
5	**WDM Network Design** • Cost Trade-offs: A detailed Ring Network example • LTD and RWA Problems • Routing and Wavelength assignment • Dimensioning wavelength networks • Statistical wavelength routing networks- First passage model, Blocking model • Maximum load dimensioning models- offline lightpath request, online RWA in Rings	06
6	**Deployment Consideration** • Architectural choices for next generation transport Network • Designing the transmission Layer using SDM,TDM and WDM • Unidirectional versus bidirectional WDM Systems- Long haul networks case study, Long Haul Undersea Networks • Metro Networks, Metro Ring Case study	06

Textbooks and References:

1. "*Optical Fiber Communications*"-Gerd Keiser-Fourth Edition-TATA McGRAW
2. "*Optical Fiber Communications Principles and Practice*"-John.M.Senior-Pearson Education HILL
3. "*Fiber Optics Communication System*"-G.P.Agarwal-Wiley Publications
4. "*Fiber Optics Communications*"- Harold Kolimbris-Pearson Education
5. "*Opto-Electronics, an introduction*"-Wilson and Hawkes,Prentice Hall
6. "*Nonlinear Fiber Optics*" G.P.Agarwal-Academic Press
7. " *Applications of Nonlinear Optics*", Academic press-G.P. Agarwal
8. "*Optical Networks, A Practical Perspective*", Third edition- Rajiv Ramaswami, Kumar N. Sivarajan, Elsevier
9. *"Optical Networks, Third generation Transport Systems*",by Uyless Black, Pearson
10. "*Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink*" by Le Nguyen Binh, CRC Press, 2010

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC103	**Modern Digital Signal Processing Applications**	**04**

Course Pre-requisite:

- Signals & Systems
- Discrete Time Signal Processing

Course Objectives:

The aim of this course is to provide in-depth treatment on methods and techniques in

- Power spectrum estimation, Adaptive filtering, Wavelet transforms.
- Applications of Signal Processing to real world problems

Course Outcome:

Learners will be able to:

- Implement adaptive filters for a given application; study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
- Apply Signal processing tools to biomedical signal processing and musical sound processing.

Module	Detailed Content	Hours
1	**Spectrum Estimation** • Non- Parametric methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods for Periodogram estimation: Bartlett, Welch and Blackman and Tukey methods. • Parametric Methods of Power Spectrum Estimation: AR, MA & ARMA models for power spectrum estimation. Yule-Walker method for the AR model parameter	08
2	**Introduction to Adaptive systems** • Introduction, Characteristics, Examples of Adaptive systems, Applications. The adaptive system -linear combiner- Description, Weight vectors, desired response performance function- Gradient and mean square error.	06
3	**Adaptive Signal Processing and Applications** • FIR Adaptive filters - Adaptive Direct Form FIR Filters based on steepest descent method -Widrow Hoff LMS Adaptive algorithm. Adaptive Direct Form FIR Filters-RLS Algorithms. • Applications: Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation.	08
4	**Wavelet Theory** • Fourier Transform and its Limitations – Short Time Fourier Transform – Introduction to time frequency analysis- Continuous Wavelet Transform – Discrete Time Wavelet	10

	Transform- Multi-resolution analysis– Haar Wavelet – Daubechies Wavelet, Filter bank theory. • Application of wavelet theory to signal denoising, speckle removal, and signal compression.	
5	**Application of Digital Signal Processing to Biomedical Signal Processing** • Detection of fetal heartbeats during labor- Fetal ECG, ECG preprocessing, QRS template, QRS detection methods, performance measure for QRS detection. • Adaptive removal of ocular artefacts from human EEGs- Methods for removal and control of ocular artefacts, online Ocular Artefacts Removal (OAR) algorithm and system, hardware for online OAR system, system testing and experimental results.	08
6	**Application of Digital Signal Processing in Musical Sound Processing** • Musical sound processing - Time domain operations- single echo filter, multiple echo filter, Reverberation, Flanging, Chorus generator, Frequency domain operations-Analog filters, First order digital filters and Equalizers, Second order digital filters and Equalizers.	08

Textbooks and References:

Textbooks:

1. John G. Proakis and Dimitris G. Manolakis, "*Digital Signal Processing*", PHI, 2005.
2. Bernard Widrow and Samuel D.Strearns, "*Adaptive Signal Processing*", Pearson Edu Asia 2002.
3. S. M. Kay, *Modern Spectrum Estimation Theory and Application*", PHI.
4. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, "*Insight into Wavelets: From theory to practice*, Third Edition PHI, 2010.
5. Raghuveer. M. Rao and Ajit S.Bopardikar, "*Wavelet Transforms -Introduction to theory and applications*, Pearson Education, Asia, 2000.
6. Rangaraj M. Rangayyan, "*Biomedical Signal Analysis- A Case Study Approach*", Wiley 2002.
7. Willis J. Tompkins, *Biomedical Digital Signal Processing*, PHI, 1999
8. Sen M Kuo, Bob H Lee and W Tian, "*Real Time Signal processing: Fundamentals, Implementations and Applications*" Springer, Wiley Publishers, Third Edition 2013.
9. S. K. Mitra, "*Digital Signal Processing*", TMH, 2001
10. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing, A Practical Approach*", Pearson Education, 2008.

Reference Books:

1. Simon Haykin, "*Adaptive Filter Theory*", Pearson Edu, 2013
2. D. C. Reddy, *Biomedical Signal Processing Principles and Techniques*, Tata Mc Graw-Hill, 2005
3. A. H. Sayed, "*Adaptive filters*", Wiley Student Edition, 2010
4. S. Thomas Alexander, *Adaptive signal processing-Theory and Applications*, Springer – Verlag.
5. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
6. Mark Kahrs, Karlheinz Brandenburg, "*Applications of Digital Signal Processing to Audio and Acoustics*", Kluwer Academic Publishers, 2002
7. Mallat, Stéphane. "*A wavelet tour of signal processing*." Academic press, Third Ed. 2008.
8. Torrence, Christopher, and Gilbert P. Compo, "*A practical guide to wavelet analysis*." Bulletin of the American Meteorological society Jan. 1998
9. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo. "*Introduction to wavelets and wavelet transforms*." Prentice Hall Inc. 1997
10. Paul S. Addison, "*The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance*." CRC press, 2002

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO1011	**Next Generation Networks**	**04**

Course Pre-requisite:

- Computer Networks
- Wireless Networks
- Mobile Communication

Course Objectives:

The aim of this course is

- To relate the paradigm shift from circuit switched network to packet switched network.
- To apply the advancement in networks field.
- To examine new technologies in telecommunication.
- To appraise the NGN Standards

Course Outcome:

Learners will be able to:

- Relate and compare the core differences between traditional and new telecommunication technologies.
- Analyze, implement and apply the components of NGN architecture with NGN standards.

Module	Detailed Content	Hours
1	**Next Generation Technologies, Networks and Services** • Introduction, • Next Generation (NG) Technologies, • Wire line NG Technologies, • FTTP, Long-Haul Managed Ethernet.	08
2	**Wireless NG Technologies** • Long Term Evolution (LTE), • Enhanced HSPA Evolution Data Optimized (EVDO), Ultra Mobile Broadband (UMB), • SDR and cognitive radio • IoT, VOIP, IPTV, Quality of Services, Quality of Experiences in NGN.	10
3	**Next Generation Multiservice Technology Overview** • MPLS &QoS, MPLS services and components, overview of VPN, layer2 VPN, layer 3 VPN	06
4	**ITU NGN Standards and Architectures** • Main drivers to Next Generation Networks – NGN , ITU NGN standards • All-IP network concept for NGN , • NGN control architectures and protocols(TISPAN),Numbering,	08

	naming and addressing for all NGN	
5	**Control and Signalling Protocols for NGN** (SIP, Diameter) • NGN security(AAA, identity management) , • Service convergence • Fixed-Mobile Convergence (FMC) in NGN, • IP Multimedia Subsystem (IMS) for NGN	08
6	**Transition to NGN and Future Evolution** • Migration of PSTN networks to NGN , • Transition of IP networks to NGN, • IPv6, NGN Evolution.	08

Textbooks and References:

Textbooks:

1. *Wireless communication and Networking*-Vijay Garg, ELSEVIER Inc.
2. Next Generation Telecommunications Network, Parliament office of Science and Technology (Postnote). Dec 2007, No. 296 Ref. www.parliament.uk.

Reference Books

1. ITU Manual
2. *Next Generation Telecommunications Networks, Services, and Management* by Thomas Plevyak, VeliSahin, ISBN: 978-0-470-57528-4 , Wiley-IEEE Press
3. *Next Generation Wireless Systems and Networks:* Hsiao – Hwa Chen, Mohsen Guizani – Wiley
4. *IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols*- Jyh- Cheng Chenand Tao Zhang- Wiley

Assessment

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO1012	**Advanced Antenna Design**	**04**

Course Pre-requisite:

- Wave Theory and Propagation
- RF and Antenna

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in microstrip antennas,
- To explain various methodologies presently prevalent for design of microstrip antennas
- To enable students to make design decisions in microstrip antennas

Course Outcome:

Learners will be able to:

- Design and analyze microstrip antennas,
- Correlate the fundamental design of antenna to advanced communication applications

Module	Detailed Content	Hours
1	**Review of Antennas** • Antenna parameters • Infinitesimal dipole antenna • Half wave dipole antenna	04
2	**Microstrip Antennas** • Introduction, Rectangular patch and Circular patch design • Quality factor, Bandwidth, Efficiency, Input impedance, and Coupling • Analytical models for MSAs transmission line models, cavity model, Multimode network model.	08
3	**Circular Polarization Technique** • Dual-Feed circularly polarized MSAs, Square MSA with two feeds, Effect of amplitude and phase imbalance, Square MSA with four feeds, CMSA with multiple feeds • Single-feed circularly polarized MSA, Diagonally fed nearly square MSA, Square MSA with modified edges, Square MSA with modified corners, Square MSA with a diagonal slot. • Broadband circularly polarized MSA, Dual-feed planar multiresonator MSA, Stacked MSA for circular polarization, Aperture coupled circularly polarized MSA, Sequentially rotated MSA.	10
4	**Planar Monopole Antennas**	10

	• Introduction, Planar Rectangular and Square Monopole Antennas, RMSA Suspended in Air with Orthogonal Ground Plane, Calculation of the Lower Frequency of the Planar Monopole Antennas. • Effect of Various Parameters of Planar Rectangular Monopole (RM) Antennas, Radiation Pattern of RM Antennas • Various Planar RMs with Equal Areas, Planar Circular Monopole Antennas.	
5	**Broadband and Compact Microstrip Antennas** • Mechanism of Parasitic Coupling for Broad BW, Gap-Coupled RMSAs, Radiating-Edge Gap-Coupled RMSAs, Multilayer Broadband MSA, Design Examples. • Compact Shorted RMSAs, Partially Shorted RMSAs, Effect of Dimensions of RMSAs with a Single Shorting Post, Effect of the Position of the Single Shorting Post	08
6	**Next generation Antennas** • Introduction to smart antennas, smart Antenna configurations-switched beam antennas and adaptive antenna approach, Smart Antennas' Benefits and draw backs, Antenna Beam forming, Architecture of Smart antenna system. • Metamaterial Antennas: Introduction, Negative Refractive Index (NRI) Metamaterials, Metamaterial Antennas Based on NRI concepts. • Applications of Smart Antennas: Smart antennas for Code Division Multiple Access Systems, Smart antennas for automatic radio frequency identification readers, Mutual coupling reduction techniques in MIMO.	08

Textbooks and References:

1. *Antenna Theory*- C. A. Balanis- Wiley and sons
2. *Antennas* – John. D. Krauss- TMH ed.
3. *Microstrip Antenna Design Handbook* - Ramesh Garg- Artech House.
4. *Handbook of Microstrip Antennas* - James R. James, Peter S. Hall-IEE Electromagnetic wave series.
5. *Broadband Microstrip antennas* – Girish Kumar and K.P. Ray, Artech House
6. *Smart Antennas for Wireless Communications with MATLAB*: Frank Gross, McGRAW Hill.
7. *Handbook on Advancements in Smart Antenna Technologies for Wireless Networks*-Chen Sun, Jun Cheng and Takashi Ohira, Information science reference, New York.

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Subject Code	Subject Name	Credits
ETDLO1013	**Image Analysis using Machine learning**	**04**

Course Pre-requisite:

- Image and Video processing

Course Objectives:

The aim of this course is

- To provide exposure to students in gaining knowledge on concepts and understanding of Image Analysis.
- To give necessary knowledge of digital image analysis for further research within the area and to be able to use digital image analysis within other research areas such as computer graphics, image coding, video coding and industrial image processing problems.
- To prepare the student for further studies in e.g. computer vision, multispectral image analysis and statistical image analysis.

Course Outcome:

Learners will be able to:

- Demonstrate good capability to independently identify problems which can be solved with methods from image analysis, and be able to choose an appropriate method.
- Independently apply basic methods in image processing to problems which are relevant in industrial applications or research.
- Explain the solution to a problem in image analysis in a well structured manner and with clear logic.

Module	Detailed Content	Hours
1	**Introduction to Image Processing** • Basic mathematical concepts: Image transforms, Discrete Fourier Transform, Fast Fourier Transform. • Image enhancement: Grey level transforms, filtering. Extraction of special features: Filtering, edge and corner detection. Image Segmentation and mathematical morphology.	08
2	**Image Representation** • Boundary Representation: Chain Code, Polygonal Approximations, Signatures, Bending Energy, Statistical Moments, Region Representation • Boundary Descriptions: Simple Descriptor, Shape Number, Fourier Descriptor, Run-length Code, Projection, Concavity Tree.	06

	• Component Labelling: Component counting, Recursive Algorithm, Sequential Algorithm.	
3	**Feature Extraction** • Histogram (or Brightness) Features, Shape Features, Spatial Moment, Central Moment, Topological Features, Geometrical Features, Transform Features, Texture Features, Syntactic and Structural Features	08
4	**Evaluating Hypotheses** • Estimating Hypothesis Accuracy, Basics of Sampling Theory, Deriving confidence intervals, difference in error of two hypotheses, Comparing Learning Algorithms.	06
5	**Learning Algorithms** • Decision Tree Learning : Building Single and Multiple Decision Trees Selecting the Decision Tree to be Built, Obtaining Prules from Decision Trees, Missing Attribute Values, Classifying with Relabelled Nodes, Error Rates on Recall Sets, Pruning Decision Trees, Issues in decision tree learning. • Bayes Learning : Bayes Theorem and concept learning, Bayesian Belief Networks, Naive Bayes with Binary Attributes, Performance of Bayes Classifier • Instance Based Leaning : K-nearest neighbour learning, case based learning, radial basis functions • Deep Learning Algorithm : Deep Networks, Deep Belief Networks, Convolutional Networks,	08
6	**Image Classification** Image Classification using • Neural network: Issues in neural network learning, perceptrons, multilayer network & Back propagation Algorithm. • Fuzzy Systems: Fuzzy logic, Fuzzification, Fuzzy inference, fuzzy rule based system, defuzzification • Support Vector Machine : Linear Classifiers, Classifier Margin, Solving the Optimization Problem, Hard Margin and Soft Margin, Linear and Non Linear SVMs, Kernel functions, • Genetic Algorithms : Genetic operators, genetic programming, models of evolution & learning, parallelizing genetic algorithm	12

Textbooks and References:

Textbooks:

1. Mitchell, Tom. *Machine Learning*. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
2. Haykin, Simon S. Neural Networks and Learning Machines, 3rd edition Pearson 2008.
3. Sonka, Milan. Hlavac Vaclav. Boyle Roger. *Image Processing, Analysis and Machine Vision*, New Delhi: Thomson Learning, 2001. ISBN: 9812400613.
4. Rajasekaran S, Vijaylakshmi Pai G.A. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Application. New Delhi, Prentice Hall of India.
5. Valluru, Sudarshan K. Rao Nageswara T., Introduction to Neural Networks, Fuzzy Logic & Genetic algorithms, Jaico Publishing House 2010.

Reference Books:

1. Bishop, Christopher. *Pattern recognition and machine learning*, Springer Verlag, 2006.
2. Shinghal Rajjan, Pattern Recognition Techniques and Applications. New Delhi Oxford University Press, 2011. ISBN 9780195676853.
3. Richards John, Jia Xiuping, *Remote Sensing Digital Image Analysis*, Springer 2006. ISBN : 9783540251286

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO1014	**Embedded Communication System Design**	**04**

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To impart the concepts and architecture of embedded systems and to make the students capable of designing embedded systems product.
- To achieve this, system design, architecture and programming of industry popular ARM Cortex is covered in detail.

Course Outcome:

Learners will be able to:

- Understand the embedded concepts and architecture of embedded systems
- Understand the architecture and programming of ARM Cortex microcontroller
- Understand the open source RTOS and their usage
- Able to design an embedded systems application
- Able to usage of the development and debugging tools

Module	Detailed Content	Hours
1	**Overview of Product Design** • Need, design challenges, product survey, specifications of product need of hardware and software, partitioning of the design into its software and hardware components, iteration and refinement of the partitioning.	06
2	**Software and Hardware** • Tradeoffs, custom single-purpose processors, general-purpose processors, memory, interfacing, design technology-hardware design, cost reduction, re-engineering, optimization, maintenance, validation and development, prototyping, turnkey product design.	06
3	**Embedded Systems and ARM Architecture** • Embedded concepts, architecture of embedded systems, ARM architecture, Cortex-M3 basics, exceptions, instruction sets, NVIC, interrupt behavior, Cortex-M3/M4 programming, memory protection unit and other Cortex-M3 features, STM32xxx ARM Cortex M3/M4 microcontroller memory and peripherals, development & debugging tools.	12
4	**Communication and Security** • Embedded systems security and secured hardware structures. Communications security in embedded systems. Embedded	04

	systems time constraints.	
5	**Multi core Architecture** • Multi-Core architecture for embedded systems, Programming models for Multi-Core, Embedded Multi-Core processing for networking.	04
6	**Open Source RTOS** • Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matric in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues – selecting a Real Time Operating System, RTOS comparative study. • Interfacing Modules: Sensor and actuator interface, data transfer and control, GPS, GSM, Bluetooth, Zigbee module interfacing with data processing and communication. IoT overview, IoT supported hardware platforms.	16

Textbooks and References:

1. *The Definitive Guide to the ARM Cortex-M3,* Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, *"ARM System Developer's Guide - Designing and Optimizing System Software",* 2006, Elsevier.
3. *Communicating Embedded Systems: Networks Applications,* Francine Krief (Editor) February 2010, Wiley-ISTE
4. Frank Vahid and Tony Givargis*, "Embedded System Design: A Unified Hardware/Software Introduction",* John Wiley publication
5. P Marwedel*, "Embedded System Design",* Springer publication
6. Christopher Hallinan*, "Embedded Linux Primer: A Practical Real-World Approach",* Second Edition, Pearson Education Publication

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From

remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ILO1011	**Product Life Cycle management**	**03**

Course Pre-requisite:

- Microcontrollers and Programming language

Course Objectives:

The aim of this course is

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course Outcome:

Learners will be able to:

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Content	Hours
1	**Introduction to Product Lifecycle Management (PLM)** • Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies** • Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM.	10
2	**Product Design** • Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic	09

	Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3	**Product Data Management** • Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
4	**Virtual Product Development Tools** • For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
5	**Integration of Environmental Aspects in Product Design** • Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
6	**Life Cycle Assessment and Life Cycle Cost Analysis** • Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Textbooks and References:

1. John Stark, "*Product Lifecycle Management: Paradigm for 21st Century Product Realisation*", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "*Product Design for the environment-A life cycle approach*", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "*Product Life Cycle Management*", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "*Product Lifecycle Management: Driving the next generation of lean thinking*", Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Some guidelines for setting the question paper. Minimum 80% syllabus

Examination: syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO1012	**Reliability Engineering**	**03**

Course Objectives:
The aim of this course is

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcome:
Learners will be able to:

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Content	Hours
1	**Probability theory** • Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions** • Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion** • Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
2	**Reliability Concepts** • Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis** • Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models** • Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08

3	**System Reliability** • System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	**Reliability Improvement** • Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. • System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
5	**Maintainability and Availability** • System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. • Availability – qualitative aspects.	05
6	**Failure Mode, Effects and Criticality Analysis** • Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Textbooks and References:

1. L.S. Srinath, "*Reliability Engineering*", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "*Reliability and Maintainability Engineering*", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "*Engineering Reliability*", John Wiley & Sons, 1980.
4. P.D.T. Conor, "*Practical Reliability Engg*.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "*Reliability in Engineering Design*", John Wiley & Sons.
6. Murray R. Spiegel, "*Probability and Statistics*", Tata McGraw-Hill Publishing Co. Ltd.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO1013	**Management Information System**	**03**

Course Objectives:
The aim of this course is

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Course Outcome:
Learners will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Content	Hours
1	**Introduction To Information Systems (IS)** • Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	04
2	**Data and Knowledge Management** • Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. **Business intelligence (BI)** • Managers and Decision Making, BI for Data analysis and Presenting Results	07
3	**Ethical issues and Privacy** • Information Security, Threat to IS, and Security Controls	07
4	**Social Computing (SC)** • Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	07
5	**Computer Networks:**	06

	• Wired and Wireless technology, Pervasive computing, Cloud computing model.	
6	**Information System within Organization** • Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. • Acquiring Information Systems and Applications: Various System development life cycle models.	08

Textbooks and References:

1. Kelly Rainer, Brad Prince, *Management Information Systems*, Wiley
2. K.C. Laudon and J.P. Laudon, *Management Information Systems: Managing the Digital Firm*, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, *Managing Information Systems: Strategy and Organization*, Prentice Hall, 2008

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGrawHill
7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

Subject Code	Subject Name	Credits
ILO1015	**Operations Research**	**03**

Course Objectives:
The aim of this course is

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Course Outcome:
Learners will be able to:

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
  Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Content	Hours
1	**Introduction to Operations Research** • Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming** • Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem** • Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem** • Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines	14

	Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem** • Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2	**Queuing models** • Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
3	**Simulation** • Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
4	**Dynamic programming** • Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
5	**Game Theory** • Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
6	**Inventory Models** • Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Textbooks and References:

1. Taha, H.A. "*Operations Research - An Introduction*", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "*Operations Research: Principles and Practice*", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "*Introduction to Operations Research*", Tata McGraw Hill, 2002.
4. *Operations Research*, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. *Operations Research*, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Some guidelines for setting the question paper. Minimum 80% syllabus

Examination: syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO1016	**Cyber Security and Laws**	**03**

Course Objectives:
The aim of this course is

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Course Outcome:
Learners will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Content	Hours
1	**Introduction to Cybercrime** • Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	04
2	**Cyber offenses & Cybercrime** • How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in • Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	09
3	**Tools and Methods Used in Cyberline** • Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	06
4	**The Concept of Cyberspace** • E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber	08

	Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
5	**Indian IT Act.** • Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	06
6	**Information Security Standard compliances** • SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	06

Textbooks and References:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi.
2. *The Indian Cyber Law* by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. *The Information technology Act*, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. *Cyber Law & Cyber Crimes* By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO1017	**Disaster management and Mitigation Measures**	**03**

Course Objectives:

The aim of this course is

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Course Outcome:

Learners will be able to:

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Content	Hours
1	**Introduction** • Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** • Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion • Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** • Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	• Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4	**Institutional Framework for Disaster Management in India:** • Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. • Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
5	**Financing Relief Measures:** • Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. • International relief aid agencies and their role in extreme events.	09
6	**Preventive and Mitigation Measures:** • Pre-disaster, during disaster and post-disaster measures in some events in general • Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication • Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. • Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Textbooks and References:

1. '*Disaster Management*' by Harsh K.Gupta, Universities Press Publications.
2. '*Disaster Management: An Appraisal of Institutional Mechanisms in India*' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. '*Introduction to International Disaster Management*' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. '*Disaster Management Handbook'* by Jack Pinkowski, CRC Press Taylor and Francis group.
5. '*Disaster management & rehabilitation'* by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. '*Natural Hazards and Disaster Management*, Vulnerability and Mitigation – R B Singh, Rawat Publications

7. *Concepts and Techniques of GIS* –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO1018	**Energy Audit and Management**	**03**

Course Objectives:
The aim of this course is

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcome:
Learners will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of a utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Content	Hours
1	**Energy Scenario** • Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles** • Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. • Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08

3	**Energy Management and Energy Conservation in Electrical System** • Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** • Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** • Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. • General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment** • On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	**Energy conservation in Buildings** • Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Textbooks and References:

1. *Handbook of Electrical Installation Practice*, Geofry Stokes, Blackwell Science
2. *Designing with light: Lighting Handbook*, By Anil Valia, Lighting System
3. *Energy Management Handbook*, By W.C. Turner, John Wiley and Sons
4. *Handbook on Energy Audits and Management*, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. *Energy Management Principles*, C.B.Smith, Pergamon Press
6. *Energy Conservation Guidebook*, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. *Handbook of Energy Audits*, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ETL101	**Laboratory-I - Optical Communication Network**	**01**

Sr. No.	Title of Experiment
1	Performance analysis of optical link in presence of group velocity dispersion
2	Designing of dispersion compensating Fiber
3	Performance Analysis of Optical Link with Different Sources
4	Performance Analysis of Optical Link with Different Detectors
5	Performance analysis of Optical Link upto 40 Gbps
6	Performance Analysis of Soliton Communication System
7	Effect of cross phase modulation on WDM system
8	Mitigation of Four wave mixing by NZ-DSF fiber.
9	Performance Analysis of Optical Amplifier
10	Performance Analysis of DWDM System

- Out of 10 Experiments any 8 experiments have to be performed.

Assessment

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETL102	**Laboratory-II - Modern Digital Signal Processing Applications**	**01**

Sr. No.	Title of Experiment
1	Demonstrate the application of Periodogram and Spectrogram
2	Pre-processing of ECG signal
3	Wavelet analysis for denoising
4	Wavelet transform for audio signal compression
5	Simulation of adaptive filtering
6	Generation of Chorus and flanging effects for voice record
7	Implementation of equalizers
8	Simulated generation of ECG signal and isolation of QRS complex
9	Analysis of EEG signals

- Out of 9 Experiments any 8 Experiments have to be performed.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETC201	**Modern Digital Communication**	**04**

Course Pre-requisite:

- Digital communication
- Random Signal Analysis

Course Objectives:

The aim of this course is to let the students obtain

- Fundamentals of modern communication system
- Ability to analyze and design digital communication systems

Course Outcome:

Learners will be able to:

- Explain and implement different source coding techniques
- Analyze waveform receivers for coherent and non-coherent communication
- Describe and design of band-limited channels
- Evaluate the detection and estimation of signals in the presence of noise.
- Explain the characteristics of fading channels.

Module	Detailed Content	Hours
1	**Source Coding** • Average ,mutual information & entropy • Coding for discrete sources • The Lempel algorithm(LZ-77,LZ-78,LZW) • Coding for analog sources -Temporal waveform coding • Spatial waveform coding	09
2	**Coherent Communication with Waveforms** • Binary cross-correlation receivers • Matched filter receivers • M-ary waveform receivers • Time-sampling approach • Karhunen-Loeve(K-L) Expansion approach • Whitening approach • Real and complex signal models • Effect of Data Imperfect Carrier Synchronization • Effect of Data Imperfect bit synchronization	08
3	**Non Coherent Communication with Waveforms** • Non Coherent receivers in random phase channels • Optimum M-FSK receivers • Non coherent receivers in random amplitude and phase	08

	channels • Optimum receivers in Rayleigh channels • Optimum receivers in Rician channels	
4	**Signal Design for Channel and Equalization** • Design of band limited signals with controlled ISI • Symbol by symbol sub optimum detection • Introduction to linear equalizer • Means square error (MSE) criterion • Iterative equalization and decoding • Introduction to adaptive equalization • The LMS Algorithm	09
5	**Optimum Detection and Estimation** • Noise vector in signal space • Bayes detection of received signal • Decision region & minimum error probability • Optimum detection of several special comm. signals	07
6	**Fading Channels** • Small scale multipath propagation • Parameters of mobile multipath channels • Types of small scale fading • Rayleigh and Rician distribution	07

Textbooks and References:

1. *Digital Communication* by John G.Proakis, 3rd Edition McGraw –Hill International Editions.
2. *Digital Communication Techniques Signal Design & Detection* by Marvin K. Simon, Sami M Hindei, William C Lindesy, PHI Learning Private Limited.
3. *Digital Communications, Fundamental & Application* by Bernard Sklar, Pabitra Kumar Ray, 2nd Edition , Pearson Publication
4. *Wireless communication principles and practice* by Theodore S. Rappaport, 2nd Edition , Pearson Publication

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students.

Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC202	**Wireless Adhoc and Sensor Networks**	**04**

Course Pre-requisite:

- Computer Networks
- Wireless Networks

Course Objectives:

The aim of this course is to let the students

- To understand the Wireless adhoc and sensor Network.
- To understand the major challenges and designing issues in designing wireless sensor and adhoc networks.
- To understand various MAC and routing protocols in wireless sensor and adhoc networks.
- To Understand Heterogeneous network architecture including MANET, WLAN, Cellular Networks.

Course Outcome:

Learners will be able to:

- Understand and explain the concept of adhoc and sensor networks and their applications.
- Set up and evaluate performance of various protocols in wireless sensor and adhoc networks.
- Understand TCP performance over adhoc network.
- Understand integration of MANET, cellular Network and WLAN.

Module	Detailed Content	Hours
1	**Introduction to MANET and Wireless Sensor Network** • Challenges and Applications of MANET, Design issues and application of sensor Network, Sensing and Communication Range, Energy and Clustering of sensors, Wireless mesh Network, Architecture and Challenging technologies.	08
2	**Routing in Adhoc Networks** • Introduction, Topology-Based versus Position-Based Approaches, Topologies-Based Routing Protocols, Position-Based Routing, Other Routing Protocols, Wireless LAN, Wireless PAN, Wireless BAN .	08
3	**Broadcasting, Multicasting, Geocasting and QoS in MANET** • Introduction, The Broadcast Storm, Multicasting, Geocasting, QOS requirements, objectives and Architecture	08
4	**TCP over Adhoc Networks** • Introduction, TCP Protocol Overview, TCP and MANETs,	06

	Solutions for TCP over Adhoc.	
5	**Design Consideration in Sensor Network** • Introduction, Classifications of WSNs, MAC Layer, Routing Layer, High Level Application Layer Support, Adapting to the Inherent Dynamic Nature of WSNs, Cognitive Radio based sensor Networks. Nano Sensor Networks.	12
6	**Integrating MANETs, WLANs and Cellular Networks** • Introduction, Ingredients of a Heterogeneous Architecture, Protocol Stack, Comparison of the Integrated Architectures.	06

Textbooks and References:

1. *Adhoc & Sensor Networks Theory and Applications* by Cordeiro, Agrawal, Cambridge University Press India Pvt. Ltd, Edition 2010.
2. *Adhoc Wireless Networks Architecture and Protocols* by C.Siva Ram Murthy and B.S.Manoj, Pearson.
3. *Adhoc & Sensor Networks* by Houda Labiod, Wiley.
4. *Wireless Communication and Networking*-Vijay Garg, Elsevier Inc.
5. *Wireless and Mobile Networks, Concepts and Protocols* by Manvi, Kakkasageri, second edition, Wiley.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETC203	**RF and Microwave Engineering**	**04**

Course Pre-requisite:

- Wave Theory and Propagation
- Radio Frequency Modelling and Antennas
- Microwave and Radar Engineering

Course Objectives:

The aim of this course is

- To provide state-of-art knowledge in RF circuits and microwave systems.
- To explain various methodologies presently prevalent for design of active and passive RF circuits.
- To enable students to make system level design decisions.
- To expose students to state-of-art simulation systems.
- To teach students Computer aided design tools for analysis and design of circuits

Course Outcome:

Learners will be able to:

- Characterize devices at higher frequencies.
- Design and analyze RF circuits and components.
- Design and analyze amplifiers, oscillators and mixers at microwave frequencies.
- Demonstrate skills of planning, design and deployment of microwave networks.

Module	Detailed Content	Hours
1	**Passive Lines and Impedance Matching Network Design** • Strip lines, Microstrip lines and coupled lines :Analysis and design • Impedance matching using lumped and distributed parameters.	06
2	**Device Characterization** • S-parameters: Properties and characterization. • Non-linear Measurements: Load/Source pull, Vector Network Analysis, Pulsed measurements • Noise Characterization: Noise Figure, Noise temperature, Noise parameters. Noise Correlation matrix.	06
3	**Amplifier Design** • Two-port power gain stability • Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design • Power amplifier design.: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier	12

4	**Frequency Generation** • One-port and two-port microwave oscillator design, Dielectric Resonator Oscillator (DRO). • Analysis of phase noise in oscillators • Mixers: Characteristics, • Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers.	10
5	**Microwave Network Design and Deployment** • Spectrum management, Interference effects and frequency shaping, Microwave system engineering. • Digital microwave radio, Digital multiplexing, Cabling and signal termination, Field surveys.	08
6	**Microwave Integrated Circuits (MIC)** • MIC materials • Types of MIC • Hybrid and monolithic MIC • Chip mathematics.	06

Textbooks and References:

1. David Pozar, "*Microwave Engineering*", Wiley Publication, Fourth Edition
2. Matthew M. Radmanesh, "*Radio Frequency and Microwave Electronics*", Pearson Education.
3. F. Giannini, G. Leuzzi, "*Non-linear Microwave Circuit Design*", Wiley Publication.
4. Harvey Lahpamer, "Microwave Transmission Networks Planning, Design and Deployment", Tata McGraw Hill, second Edition.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO2021	**Satellite Networking**	**04**

Course Pre-requisite:

- Satellite Communication and Networks
- Internet Voice and Mobile Communication

Course Objectives:

The aim of this course is

- To understand and learn advanced networking techniques with satellite systems
- To be able to devise link budget model of satellite communication for specific applications
- To be able to apply knowledge to upgrade satellite communication systems

Course Outcome:

Learners will be able to:

- Perform link budget for specific satellite application
- Learn different advanced satellite networking concepts
- Understand usage of lasers in satellites and satellite service applications

Module	Detailed Content	Hours
1	**Introduction** • Origin of satellite communications, Development, space and ground segments, types of orbits, evolution of satellite communication, Development of satellite services and Launching mechanism in the Geostationary orbit, Orbits and orbital perturbations	08
2	**System Segment and Link Analysis** • AOCS, TTC, Equipment Reliability and Space qualifications, Link analysis	08
3	**Satellite Networks Architecture and organization** • Applications and services of satellite network, network reference models, Architecture, On board connectivity, frame organisation, Window organization	10
4	**Laser Satellite Communications** • Link introduction, optical satellite link transmitter, Receiver, satellite beam acquisition, Tracking and positioning, Single hop satellite connections, multi hop satellite connections, inter satellite links	08
5	**Specific Satellite Network** • Study of IRIDIUM and GLOBALSTAR Synchronous Digital Hierarchy (SDH), Integrated services digital networks (ISDN),	08

	ISDN over satellite, Interworking with heterogeneous networks, Case studies - satellite image analysis and photogrammetry.	
6	**Satellite Applications** • Communication applications (ATM service, DTH service, TV broadcast), Earth observation applications (Urban planning, Oceanography, resource management, agriculture services), Meteorology applications weather forecasting, Space science applications (Moon topography, Planet investigation), Navigation applications (Road, desserts, aerial and marine services).	06

Textbooks and References:

1. *Satellite Communication Systems, Techniques and Technology* -5th Edition by Gerard Maral and Michel Bousquet, John Wiley Publication (Text book for chapter-1 to 5)
2. *Mobile Satellite Communication Networks* – By Ray Sheriff, Y. Fun Hu, John Wiley Publication (Text book for chapter-1 to 3)
3. *Satellite Networking: Principles and Protocols* 2nd Edition by Zhili Sun, John Wiley Publication (Text book for chapter-3 & 5)
4. *Satellite Communications* by Roddy Dennis, 5th Edition, McGraw Hill Education Publication (Reference book)
5. *Satellite Communication* – Timothy Pratt, C. Boustian, J. Allmuti, Wiley Publication (Reference Book)
6. Digital resources for case studies from internet

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO2022	**Network and Cyber Security**	**04**

Course Pre-requisite:

- Computer Communication Networks
- Operating System
- Probability Theory and Random Processes

Course Objectives:

The aim of this course is

- To introduce advanced techniques to implement security mechanisms using IDS, Firewall, and Antivirus and Biometrics, Incident handling and Forensics
- To discuss security implications on Organizations, security standards and Cyber laws.

Course Outcome:

Learners will be able to:

- Describe security threats and apply security techniques using cryptosystems.
- Explain the key terms and concepts in cyber law, intellectual property and cyber crimes, trademarks and domain theft
- Build and configure firewall and intrusion detections systems' using GNU open source security tools.
- Incorporate approaches for incident analysis and response, for risk management and best practices and digital evidence collection, and evidentiary reporting in forensic acquisition

Module	Detailed Content	Hours
1	**Introduction to Network and Cyber Security** • Need for network security, Attacks and Their classification, • Network Vulnerabilities and control • Security services and mechanisms, • Impact of Security on Enterprises • Risk Factors and Cost Analysis.	04
2	**Cryptography and Cryptosystems** • Classical and modern cryptography, stream and block ciphers, • Message digest, digital signature, digital certificate, certificate authority, cryptanalysis • DES/AES/RSA/RC4/MD5/SHA algorithms • Secure protocols SSL, IPSec, VPN,PKI • Implementing security using symmetric and Public-Key cryptography.	10
3	**Ethical Hacking and Network Differences**	10

	• Cybercrimes, Cybercriminals, Cyberoffences, Cybercrimes in Mobile and Wireless Devices, Tools and Methods used in Cybercrimes • Network reconnaissance, scanning and sniffing, gaining access. • Security Technologies: Firewall, IDS and Antivirus, Reverse proxy • L7 content filtering firewall, NAT & reverse proxy, Firewall deployment and limitations, selection of firewalls. Performance analysis of firewall. • Signature and Anamoly based IDSs, IDS deployment, zone diagram, performance analysis of IDS, strengths and limitations of IDS. • Biometrics for security	
4	**Cybersecurity Principles and best Practices** • Layered Defense, Surveillance and Reconnaissance Outsider/Internal Threat Protection, • Privacy, Intellectual Property, Professional Ethics, Freedom of Speech, Fair User and Ethical Hacking, Trademarks ,Internet Fraud ,Electronic Evidence.	8
5	**Cybersecurity Implications on Organizations, Standards and Cyber laws** • Risk Management: Asset Evaluation and Business Impact Analysis, Risk Identification, Risk Quantification, Risk Response Development and Control Security Policy, Compliance, and Business Continuity. • Cyber Incident Preparation: Incident Detection and Analysis, Containment, Eradication, and Recovery ,Proactive and Post-Incident Cyber Services • Forensics: Forensic Technologies ,Digital Evidence Collection ,Evidentiary Reporting • The Indian IT Act and new amendments.	8
6	**System Security and Case Study** • Security Operations Center (SOC), Network Operations Center (NOC), • Network Security Audit • SET, Biometric Security, Digital Immune System • Cloud Security. Wi-Fi Security, Mobile and Cellular Security.	8

Textbooks and References:

1. *Cryptography and Network Security* by Behrouz Forouzan McGrawHill Publications
2. *Security in Computing* by Pfleeger and Pfleeger, Pearson Publications
3. *Management of Information Security* by M. Whitman Cengage Publications
4. Cengage Learning India, *Network Security and Cryptography* by B. Menezes.

5. *Computer Security* by Matt Bishop, Pearson Publication
6. *Cryptography and Network Security* by William Stallings, Pearson publications.
7. *Cyber Security* by Nina Godbole, John Wiley Publications
8. *Information Security: Principles and Practice,* 2nd edition by Mark Stamp and Deven Shah.
9. *Data Communication & Network Security* by Houston Carr and Charles Snyder, McGraw-Hill Publication.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO2023	**Remote Sensing**	**04**

Course Pre-requisite:

- Digital Image Processing

Course Objectives:

The aim of this course is

- To provide exposure to students in gaining knowledge on concepts and applications of Remote Sensing
- To give exposure to participants for Digital Image Processing with more emphasis on classification
- To acquire skills in advance techniques such as hyper spectral, thermal and microwave for mapping and monitoring.

Course Outcome:

Learners will be able to:

- Demonstrate detailed, integrated knowledge of the application and history of remote sensing
- Discuss the nature of electromagnetic radiation and its interaction with the earth's surface and atmosphere
- Demonstrate a critical understanding of the differences between remote sensing systems and be aware of their characteristics and limitations
- Critically identify specific applications where remote processing may be used as a tool for monitoring and research.

Module	Detailed Content	Hours
1	**Introduction to Remote Sensing** • What is Remote Sensing (RS)? Characteristics/elements of RS systems, Electromagnetic Radiation Electromagnetic Spectrum, Polarization, Interactions with the Atmosphere (Absorption, Scattering: Rayleigh, Mie, Non selective, absorption), Radiation - Target interactions, Passive vs. Active Sensing, Basic Image processing concepts: Image as a matrix, B/W and Colour (RGB)	08
2	**Sensors** • Ground and Air, Satellite Characteristics: orbits, swaths, Spatial Resolution, Pixel Size (IFOV, resolution cell), Spectral, Radiometric, Temporal Resolution, Cameras and Aerial Photography, Multispectral and Hyperspectral Scanning, Thermal Imaging, Geometric Distortion, Different Satellites:	08

	All Weather Satellites, Land Observation, Marine Observation, LIDAR, FLIR, RADAR, Side looking Radar.	
3	**Microwave Remote Sensing** • Introduction, RADAR Basics, Viewing Geometry, RADAR Image Distortions, Target Interaction and Image Appearance, RADAR Image Properties, RADAR Polarimetry (Polarization, Signatures, Backscatter, Parameters Affecting Backscatter, Applications), Synthetic Aperture RADAR (SAR), Airborne and Spaceborne Radars. Comparison of Optical and Microwave Remote Sensing Techniques.	10
4	**Image Transforms** • Visual Image Analysis (tone, shape, size, pattern, texture, shadow, and Association), Digital Image Processing steps (Pre-processing, Enhancement, Transformation and Classification), Contrast Enhancement: Global, Local Techniques, Filtering, Image Transformations: Arithmetic Operations (Subtraction, Spectral Ratio, NDVI, PCT, FT, Color , Hough Transforms)	08
5	**Image Classification and Analysis** • Visual Interpretation, Image Classification: Optimum band selection, Supervised (Minimum Distance, Parallelopiped and Maximum Likelihood), Assessment of Classification Accuracy (Confusion or Error Matrix, Omission and Commission Error, Kappa Coefficient), Unsupervised Classification techniques: K-means, ISODATA, Fuzzy C-means, Hierarchical clustering, Evaluation Techniques	10
6	**Applications of Remote Sensing** • Agriculture, Forestry, Land Cover/ Land Use Mapping, Water Resources, Snow and Glacier, Wetland Management, Oceans and Coastal, Soil Moisture	04

Textbooks and References:

Textbooks:

1. *Fundamentals of Remote Sensing***,** George Joseph, Universities Press; Second Edition, ISBN-10: 817371535, ISBN-13: 978-8173715358
2. *Remote Sensing: Models and Methods for Image Processing***,** Robert A. Schowengerdt, Academic Press, Third Edition, ISBN-10: 8131203182, ISBN-13: 978-8131203187
3. *Remote Sensing and Image Interpretation***,** Lillesand, Kiefer, Chipman, Wiley, Sixth Edition, ISBN-10: 8126532238, ISBN-13: 978-8126532230

References Books:

1. *Introduction to Microwave Remote Sensing*, Iain H. Woodhouse, CRC Press, ISBN-10: 0415271231, ISBN-13: 978-0415271233
2. *Digital Image Processing*, Rafael C. Gonzalez, Richard Eugene Woods, Prentice Hall, Third Edition, 2013, ISBN-13: 9789332518469
3. *Digital Image Processing*, S Jayaraman , S Esakkirajan, T Veerakumar, Mcgraw Hill Education, First Edition, 2009, ISBN-10: 0070144796, ISBN-13: 9780070144798

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ETDLO2024	**Error Control Coding**	**04**

Course Pre-requisite:

- Digital Communication
- Applied Maths

Course Objectives:

The aim of this course is

- To provide students a sound knowledge of traditional and modern coding theory, the motivation behind synthesis of channel coding techniques.

Course Outcome:

Learners will be able to:

- Design channel codes for the physical layer and storage applications
- Design new channel codes for wired/wireless communication systems

Module	Detailed Content	Hours
1	**Introduction to Algebra** • Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.	08
2	**Linear Codes** • Block codes: Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes, Golay code, Product codes and Interleaved codes. • Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, Golay code, Shortened cyclic codes.	10
3	**BCH Codes** • Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm.	08

4	**Convolutional Codes** • Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.	08
5	**Concatenated Codes and Turbo Codes** • Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes with Convolutional Inner codes, Introduction to Turbo coding and their distance properties, Design of Turbo codes.	08
6	**Burst Error Correcting Codes** • Burst and Random error correcting codes, Concept of Inter – leaving, cyclic codes for Burst Error correction – Fire codes, Convolutional codes for Burst Error correction.	06

Textbooks and References:

1. Shu Lin & Daniel J. Costello, Jr. *"Error Control Coding"* Prentice Hall, Second Edition, 2004.
2. S. B Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice Hall International, 1995.
3. Blahut R. E, *Theory and Practise of Error Control Codes*, Addisson Wesley, 1983
4. Blahut R.E., *Algebraic codes for Data transmission*, Cambridge University Press, 2003.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum two modules) and the other is either a class test (on minimum three modules of the remaining) or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these, question number 1 will be compulsory and it will carry questions covering each module. From remaining questions any three questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
ILO2021	**Project Management**	**03**

Course Objectives:
The aim of this course is

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcome:
Learners will be able to:

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Content	Hours
1	**Project Management Foundation:** • Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	05
2	**Initiating Projects:** • How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	06
3	**Project Planning and Scheduling** • Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management	8

	Information System (PMIS).	
4	**Planning Projects** • Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. • Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	06
5	**Executing Projects:** • Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. • Team management, communication and project meetings. **Monitoring and Controlling Projects:** • Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** • Project procurement management, contracting and outsourcing	08
6	**Project Leadership and Ethics:** • Introduction to project leadership, ethics in projects. • Multicultural and virtual projects. **Closing the Project:** • Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	06

Textbooks and References:

1. Jack Meredith & Samuel Mantel, *Project Management: A managerial approach*, Wiley India, 7th Ed.
2. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 5th Ed, Project Management Institute PA, USA
3. Gido Clements, *Project Management*, Cengage Learning.
4. Gopalan, *Project Management*, , Wiley India
5. Dennis Lock, *Project Management*, Gower Publishing England, 9th Ed.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2022	**Finance Management**	**03**

Course Objectives:
The aim of this course is

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course Outcome:
Learners will be able to:

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Content	Hours
1	**Overview of Indian Financial System** • Characteristics, Components and Functions of Financial System. **Financial Instruments** • Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets** • Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions** • Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
2	**Concepts of Returns and Risks** • Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money** • Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and	06

	Annuity Due; Continuous Compounding and Continuous Discounting.	
3	**Overview of Corporate Finance** • Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis** • Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
4	**Capital Budgeting** • Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management** • Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
5	**Sources of Finance** • Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure** • Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
6	**Dividend Policy** • Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Textbooks and References:

1. *Fundamentals of Financial Management*, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. *Analysis for Financial Management*, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. *Indian Financial System*, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. *Financial Management*, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2023	**Entrepreneurship Development and Management**	**03**

Course Objectives:
The aim of this course is

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME.

Course Outcome:
Learners will be able to:

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
  Understand government policies for entrepreneurs

Module	Detailed Content	Hours
1	**Overview Of Entrepreneurship** • Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership • Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
2	**Business Plans And Importance Of Capital To Entrepreneurship** • Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur • **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
3	• Women's Entrepreneurship Development, Social entrepreneurship- role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
4	**Indian Environment for Entrepreneurship** • Key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of	08

	infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5	**Effective Management of Business** • Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
6	**Achieving Success In The Small Business** • Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Textbooks and References:

1. Poornima Charantimath, *Entrepreneurship development- Small Business Enterprise*, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, *Entrepreneurship*, latest edition, The McGrawHill Company
3. Dr TN Chhabra, *Entrepreneurship Development*, Sun India Publications, New Delhi
4. Dr CN Prasad, *Small and Medium Enterprises in Global Perspective*, New century Publications, New Delhi
5. Vasant Desai, *Entrepreneurial development and management*, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, *Entrepreneurship*, Excel Books
7. Rashmi Bansal, *STAY hungry STAY foolish*, CIIE, IIM Ahmedabad
8. *Law and Practice relating to Micro, Small and Medium enterprises*, Taxmann Publication Ltd.
9. Kurakto, *Entrepreneurship- Principles and Practices*, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Some guidelines for setting the question paper. Minimum 80% syllabus

Examination: syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2024	**Human Resource Management**	**03**

Course Objectives:
The aim of this course is

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Course Outcome:
Learners will be able to:

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Content	Hours
1	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	05
2	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	07

	• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor) • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
3	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	06
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	05
5	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	06
6	**HR & MIS** • Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** • Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations**	05

	• Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Textbooks and References:

1. Stephen Robbins, *Organizational Behavior*, 16th Ed, 2013
2. V S P Rao, *Human Resource Management*, 3rd Ed, 2010, Excel publishing
3. Aswathapa, *Human resource management: Text & cases*, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, *Dynamics of Industrial Relations in India*, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, *Essentials of Human Resource management and Industrial relations*, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, *Management & Organizational Behavior*, Latest Ed, 2016, Pearson Publications

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Course Objectives:
The aim of this course is

- To understand professional ethics in business
- To recognized corporate social responsibility

Course Outcome:
Learners will be able to:

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Content	Hours
1	**Professional Ethics and Business:** • The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
2	**Professional Ethics in the Marketplace** • Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment** • Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
3	**Professional Ethics of Consumer Protection** • Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination** • Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
4	**Introduction to Corporate Social Responsibility** • Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. • Trajectory of Corporate Social Responsibility in India	05
5	**Corporate Social Responsibility** • Articulation of Gandhian Trusteeship Corporate Social	08

	Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
6	**Corporate Social Responsibility in Globalizing India** • Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Textbooks and References:

1. *Business Ethics: Texts and Cases from the Indian Perspective (2013)* by Ananda Das Gupta; Publisher: Springer.
2. *Corporate Social Responsibility: Readings and Cases in a Global Context (2007)* by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. *Business Ethics: Concepts and Cases*, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. *Corporate Social Responsibility in India (2015)* by Bidyut Chakrabarty, Routledge, New Delhi.

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2026	**Research Methodology**	**03**

Course Objectives:
The aim of this course is

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcome:
Learners will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
  Review and analyze research findings

Module	Detailed Content	Hours
1	**Introduction and Basic Research Concepts** • Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology • Need of Research in Business and Social Sciences • Objectives of Research • Issues and Problems in Research • Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
2	**Types of Research** • Basic Research • Applied Research • Descriptive Research • Analytical Research • Empirical Research • Qualitative and Quantitative Approaches	07
3	**Research Design and Sample Design** • Research Design – Meaning, Types and Significance • Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
4	**Research Methodology** • Meaning of Research Methodology	08

	• Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
5	**Formulating Research Problem** • Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
6	**Outcome of Research** • Preparation of the report on conclusion reached • Validity Testing & Ethical Issues • Suggestions and Recommendation	04

Textbooks and References:

1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques*, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nded), Singapore, Pearson Education

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2027	**IPR and Patenting**	**03**

Course Objectives:
The aim of this course is

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course Outcome:
Learners will be able to:

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Content	Hours
1	**Introduction to Intellectual Property Rights (IPR)** • Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment** • Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
2	**Enforcement of Intellectual Property Rights** • Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR** • Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
3	**Emerging Issues in IPR** • Challenges for IP in digital economy, e-commerce, human	05

	genome, biodiversity and traditional knowledge etc.	
4	**Basics of Patents** • Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
5	**Patent Rules** • Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
6	**Procedure for Filing a Patent (National and International)** • Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases** • Important websites, Searching international databases	07

Textbooks and References:

1. Rajkumar S. Adukia, 2007, *A Handbook on Laws Relating to Intellectual Property Rights in India*, The Institute of Chartered Accountants of India
2. Keayla B K, *Patent system and related issues at a glance*, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, *Intellectual Property Law in India*, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, *Intellectual Property and Human Development: Current Trends and Future Scenario*, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right*, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, *The enforcement of Intellactual Property Rights: A Case Book*, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, *Intellectual Property Rights*, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, *Intellectual Property Rights*, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, *Intellectual Property Rights*, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, *Fundamentals of IPR for Engineers*, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, *A Manual on*

Intellectual Property Rights.
12. Mathew Y Maa, 2009, *Fundamentals of Patenting and Licensing for Scientists and Engineers*, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** *IPR: Drafting, Interpretation of Patent Specifications and Claims***,** New India Publishing Agency
14. Vivien Irish, 2005, *Intellectual Property Rights for Engineers*, IET
15. Howard B Rockman, 2004, *Intellectual Property Law for Engineers and scientists*, Wiley-IEEE Press

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2028	**Digital Business Management**	**03**

Course Objectives:
The aim of this course is

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course Outcome:
Learners will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed Content	Hours
1	**Introduction to Digital Business** • Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts • Difference between physical economy and digital economy, **Drivers of digital business** • Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) • Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** • **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement • B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals • Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing • EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**	06

	• ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development** • Building Digital business Applications and Infrastructure	
4	**Managing E-Business** • Managing Knowledge, Management skills for e-business, Managing Risks in e –business • Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy** • E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, • E-business strategy into Action, challenges and E-Transition • (Process of Digital Transformation)	04
6	**Materializing e-business** • From Idea to Realization-Business plan preparation • Case Studies and presentations	08

Textbooks and References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. *E-commerce from vision to fulfilment*, Elias M. Awad, PHI-Restricted, 2002
3. *Digital Business and E-Commerce Management*, 6th Ed, Dave Chaffey, Pearson, August 2014
4. *Introduction to E-business-Management and Strategy*, Colin Combe, ELSVIER, 2006
5. *Digital Business Concepts and Strategy*, Eloise Coupey, 2nd Edition, Pearson
6. *Trend and Challenges in Digital Business Innovation*, Vinocenzo Morabito, Springer
7. *Digital Business Discourse* Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. *Perspectives the Digital Enterprise –A framework for Transformation*, TCS consulting journal Vol.5
10. *Measuring Digital Economy-A new perspective* -DOI:10.1787/9789264221796-en OECD Publishing

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ILO2029	**Environmental Management**	**03**

Course Objectives:
The aim of this course is

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course Outcome:
Learners will be able to:

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Content	Hours
1	**Introduction and Definition of Environment** • Significance of Environment Management for contemporary managers, Career opportunities. • Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
2	**Global Environmental concerns** • Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
3	**Concepts of Ecology** • Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
4	• Scope of Environment Management, Role & functions of Government as a planning and regulating agency. • Environment Quality Management and Corporate Environmental Responsibility	10
5	• Total Quality Environmental Management, ISO-14000, EMS certification.	05
6	• General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Textbooks and References:

1. *Environmental Management: Principles and Practice*, C J Barrow, Routledge Publishers London, 1999
2. *A Handbook of Environmental Management* Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. *Environmental Management*, T V Ramachandra and Vijay Kulkarni, TERI Press
4. *Indian Standard Environmental Management Systems* — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. *Environmental Management: An Indian Perspective*, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. *Introduction to Environmental Management*, Mary K Theodore and Louise Theodore, CRC Press
7. *Environment and Ecology*, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question paper. Minimum 80% syllabus syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Subject Code	Subject Name	Credits
ETL201	**Laboratory-III - Wireless Adhoc and Sensor Networks**	**01**

Sr. No.	Title of Experiment
1	Study and Implementation of technical paper from the reputed Journal related to Adhoc and Wireless Sensor Networks by using any Simulator/tool. Or Implementing one hardware project related to WSN.
2	Implementation /Simulation of any two Routing Protocols in Adhoc Networks.
3	Implementation /Simulation of any two Routing Protocols in Wireless Sensor Networks.
4	Implementation /Simulation of any two MAC Protocols in Wireless Sensor Networks.

Simulator or Software can be NS2, NS3, MATLAB/SCILAB, NETSIM, etc.

Assessment

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETL202	**Laboratory -IV- RF and Microwave Engineering**	**01**

Sr. No.	Title of Experiment
1	Study and calibration of vector network analyzer.
2	Measurement of S-parameters of one-port network.
3	Measurement of S-parameters of two-port network.
4	Stability analysis of two-port amplifier circuit.
5	Noise analysis of two-port amplifier circuit.
6	Design and analysis of microstrip line/ passive components.
7	Design and analysis of various matching networks using CAD tools.
8	Design and simulation of amplifier circuits using CAD tools.
9	Design and simulation of oscillator circuits using CAD tools.
10	Analysis of mixer spurs.

- Out of the 10 experiments, any 8 experiments to be performed.

Assessment

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners. (Examiners will be from PG recognized teachers)

Subject Code	Subject Name	Credits
ETS301	**Special Topic Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Electronics and Telecommunication Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format and present infront of Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.
- Seminar should be assessed based on following points
  1. Quality of Literature survey and Novelty in the topic
  2. Relevance to the specialization
  3. Understanding of the topic
  4. Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from PG Recognized Teachers by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
ETD301	**Dissertation I**	**12**
ETD401	**Dissertation II**	**15**

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by Analytical/ simulation/ experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  1. Quality of Literature survey and Novelty in the problem
  2. Clarity of Problem definition and Feasibility of problem solution
  3. Relevance to the specialization
  4. Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners (PG Recognized Teachers) appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  1. Quality of Literature survey and Novelty in the problem
  2. Clarity of Problem definition and Feasibility of problem solution
  3. Relevance to the specialization or current Research / Industrial trends
  4. Clarity of objective and scope
  5. Quality of work attempted
  6. Validation of results
  7. Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai
- Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)

AC : 23/07/2020

Item No.: 139

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Biomedical Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 23/07/2020
Item No.: 139

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Biomedical Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande

Associate Dean

Faculty of Science and Technology

Member, Academic Council, RRC in Engineering

University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande

Associate Dean

Faculty of Science and Technology

Member, Academic Council, RRC in Engineering

University of Mumbai

Preface By BoS

Engineering is an innovative field, the origin of ideas leading to everything from automobile to aerospace, skyscrapers to sonar. **Biomedical Engineering** focuses on the advances that improve human health and health care at all levels. Biomedical engineering is an interdisciplinary field with application of the principles of Basic Sciences, Mathematics, Engineering fundamentals and Biology for problem-solving.

The curriculum is designed to meet the challenges by include new age courses on Machine Learning, Artificial Intelligence, Data Analytics and other emerging technologies, dismantling the walls between engineering and scientific disciplines. The key to generate a new paradigm shift for careers in Biomedical Engineering for the next generation of talented minds lies in imparting high-quality education in Engineering.

Every course in the curriculum lists the course objectives and course outcomes for the learners to understand the skills that the learner will acquire after completing that course. Program outcomes are the skills and knowledge that a student will acquire during the course of four years of this engineering program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Biomedical Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for undergraduate program were thoughtfully framed by faculty members from different affiliated institutes of the university. They are Heads of Departments and senior representatives from the Department of Biomedical Engineering.

The Program Educational Objectives for the undergraduate program in Biomedical engineering are listed below;

1. To prepare the learner with a sound foundation in the Human Physiology, Mathematics, Electronics, Computer Programming and engineering fundamentals.

2. To motivate the learner for self-learning, logical & analytical thinking and use of modern tools for solving real life problems.

3. To impart technical knowledge, competency skills, professional and ethical attitude, good leadership qualities to contribute in the field of healthcare.

4. To prepare the Learner for a successful career in healthcare industry such as sales & marketing, research & development, hospital administration and also to venture into higher education and entrepreneurship.

Board of Studies in Biomedical Engineering

Dr. Manali J. Godse : Chairman

Dr. Prem C. Pandey : Member

Dr. Mita Bhowmick : Member

Dr. Mrunal R. Rane : Member

Dr. Vaibhavi A. Sonetha : Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC301	Engineering Mathematics - III	3	--	1	3	--	1	4
BMC302	Human Anatomy and Physiology for Engineers	3		--	3		--	3
BMC303	Medical Sensors	3	--	--	3	--	--	3
BMC304	Electronic Circuits Analysis and Design	4	--	--	4	--	--	4
BMC305	Digital Electronics	3	--	--	3	--	--	3
BML301	Human Anatomy and Physiology for Engineers Lab	--	2	--	--	1	--	1
BML302	Medical Sensors Lab	--	2	--	--	1	--	1
BML303	Electronic Circuits Analysis and Design Lab	--	2	--	--	1	--	1
BML304	Electronics Lab (SBL)	--	4	--	--	2	--	2
BMM301	Mini Project – 1 A	--	4$	--	--	2	--	2
Total		**16**	**14**	**1**	**16**	**07**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)	Term Work	Pract/ oral	Total
		Test 1	Test 2	Avg.					
BMC301	Engineering Mathematics - III	20	20	20	80	3	25	--	125
BMC302	Human Anatomy and Physiology for Engineers	20	20	20	80	3	--	--	100
BMC303	Medical Sensors	20	20	20	80	3	--	--	100
BMC304	Electronic Circuits Analysis and Design	20	20	20	80	3	--	--	100
BMC305	Digital Electronics	20	20	20	80	3	--	--	100
BML301	Human Anatomy and Physiology for Engineers Lab	--	--	--	--	--	25	--	25
BML302	Medical Sensors Lab	--	--	--	--	--	25	25	50
BML303	Electronic Circuits Analysis and Design Lab	--	--	--	--	--	25	25	50
BML304	Electronics Lab (SBL)	--	--	--	--	--	25	25	50
BMM301	Mini Project – 1 A	--	--	--	--	--	25	--	25
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**725**

$ indicates work load of Learner (Not Faculty), for Mini Project - 1 A.

Faculty Load :1 hour per week per 4 mini project groups.

Program Structure for Second Year Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC401	Engineering Mathematics - IV	3	--	1	3	--	1	4
BMC402	Integrated Circuit Design	3	--	--	3	--	--	3
BMC403	Principles of Control Systems	3	--	--	3	--	--	3
BMC404	Medical Imaging – I	3	--	--	3	--	--	3
BMC405	Biomaterials and Artificial Organs	3	--	--	3	--	--	3
BML401	Integrated Circuit Design Lab	--	2	--	--	1	--	1
BML402	Principles of Control Systems Lab	--	2	--	--	1	--	1
BML403	Medical Imaging – I Lab	--	2	--	--	1	--	1
BML404	Computing Lab (SBL)	--	4	--	--	2	--	2
BMM401	Mini Project – 1 B	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
BMC401	Engineering Mathematics - IV	20	20	20	80	3	25	--	125
BMC402	Integrated Circuit Design	20	20	20	80	3	--	--	100
BMC403	Principles of Control Systems	20	20	20	80	3	--	--	100
BMC404	Medical Imaging – I	20	20	20	80	3	--	--	100
BMC405	Biomaterials and Artificial Organs	20	20	20	80	3	--	--	100
BML401	Integrated Circuit Design Lab	--	--	--	--	--	25	25	50
BML402	Principles of Control Systems Lab	--	--	--	--	--	25	--	25
BML403	Medical Imaging – I Lab	--	--	--	--	--	25	25	50
BML404	Computing Lab (SBL)	--	--	--	--	--	25	25	50
BMM401	Mini Project – 1 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**100**	**750**

$ indicates work load of Learner (Not Faculty), for Mini Project - 1 B.

Faculty Load :1 hour per week per 4 mini project groups.

Semester – III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
BMC301	**Engineering Mathematics-III**	03	-	01	03	-	01	**04**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
BMC301	**Engineering Mathematics-III**	20	20	20	80	25	-	-	**125**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and Vector product of three and four vectors.

Course Code	Course Name	Credits
BMC301	**Engineering Mathematics - III**	**04**
Course Objectives	• To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications. • To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills • To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane. • To understand the basics of Linear Algebra and its applications • To use concepts of vector calculus to analyze and model engineering problems.	
Course Outcomes	On successful completion of course learner will be able to: • Apply the concept of Laplace transform to solve the real integrals in engineering problems. • Apply the concept of inverse Laplace transform of various functions in engineering problems. • Expand the periodic function by using Fourier series for real life problems and complex engineering problems. • Find orthogonal trajectories and analytic function by using basic concepts of complex variables. • Illustrate the use of matrix algebra to solve the engineering problems. • Apply the concepts of vector calculus in real life problems.	

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace Transform. 1.2 Laplace Transform (L) of standard functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale Property, Multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	**7**
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace Transform using derivatives. 2.2 Partial fractions method to find inverse Laplace Transform. 2.3 Inverse Laplace Transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories. **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7
05	**Module: Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley- Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices, Functions of square matrix. **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Module: Vector Differentiation and Integra**l 6.1 **Vector differentiation**: Basics of Gradient, Divergence and Curl (Without	6

	Proof). 6.2 **Properties of vector field:** Solenoidal and Irrotational (conservative) vector fields. 6.3 **Vector integral:** Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:** Gauss' divergence Theorem and applications of Vector calculus.	

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of marks for term work shall be as follows:

Class Tutorials on entire syllabus : 10 Marks
Mini project : 10 Marks
Attendance (Theory and Tutorial) : 5 Marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approximately 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:-

1. Advanced engineering mathematics, H.K. Das, S.Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC302	Human Anatomy and Physiology for Engineers (Abbreviated as HAPE)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC302	Human Anatomy and Physiology for Engineers (Abbreviated as HAPE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC302	Human Anatomy and Physiology for Engineers	03
Course Objectives	• To understand the anatomical structures of the human body and their relationship to each other. • To understand the different physiological processes taking place inside the human body.	
Course Outcomes	Learners will be able to: • Explain the organization of the human body, homeostasis and its maintenance, structure and functions of a cell and basic tissues. • Explain the components of blood and their functions. • Explain the anatomical parts and physiological processes of the cardiovascular system and respiratory system. • Explain the anatomical parts and physiological processes of the alimentary system and renal system. • Explain the structure and functions of nervous system, eye and skin along with the secretions and functions of all endocrine glands.	

Module	Contents	Hours
1.	**Introduction to the Human Body:** Levels of structural organization; Characteristics of living human organism; Homeostasis and its maintenance. **Cells and Tissues**: Structure and functions of a cell; Transport across the plasma membrane; membrane potentials; Tissues: epithelial, connective, muscle and nervous.	**04**
2.	**Cardiovascular System**: Anatomy of the heart; Heart valves, systemic and pulmonary circulation; Conduction system of the heart; Cardiac action potential, electrocardiogram (ECG); Cardiac cycle; Cardiac output; Blood pressure. **Respiratory System:** Anatomy of respiratory system; Pulmonary ventilation, lung volumes and capacities; Gas laws - Dalton's law and Henry's law, external respiration, internal respiration.	**10**
3.	**Blood:** Composition of Blood, blood cells and their functions, haemoglobin; Blood Grouping; Haemostasis.	**04**
4.	**Alimentary System:** Anatomy of the alimentary system; Secretions of different organs of the alimentary system and their main functions. **Renal System:** Anatomy of the renal system; Functions of kidney (urine formation, electrolyte balance and *pH* balance); composition of urine; Micturition.	**10**
5.	**Nervous System:** Divisions of the nervous system (central and peripheral nervous system); Structure and functions of the brain and spinal cord; Reflex actions and reflex arc; Functions of sympathetic and parasympathetic nervous system; Nerve action potential and nerve conduction.	**05**
6.	**Special Senses:** Structure of the eye; Physiology of vision; Structure and functions of the skin. **Endocrine System:** All Glands of the endocrine system, their secretions and functions.	**06**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:
1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Publication)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:
1. Physiology of Human Body: Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int.)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub.)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

NPTEL/Swayam Course:
Course: Animal Physiology by Prof. Mainak Das - IIT Kanpur
https://nptel.ac.in/courses/102/104/102104058/
https://swayam.gov.in/nd1_noc20_bt42/preview

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.

3. Q.1 will be compulsory, based on entire syllabus wherein subquestions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC303	Medical Sensors (Abbreviated as MS)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dur-ation (hrs)					
		Test 1	Test 2	Avg.							
BMC303	Medical Sensors (Abbreviated as MS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC303	Medical Sensors	03
Course Objectives	• To provide the knowledge of basic concepts such as generalized medical instrumentation system, input transducer properties, and instrument characteristics. • To provide a thorough understanding of principle and working of transducers and sensors used for measuring displacement, motion, force, pressure, temperature, bio-potentials, biochemical concentrations. • To study the medical applications of the above transducers and sensors. • To perform experiments based on some of the above transducers and sensors.	
Course Outcomes	The learner will be able to : • Explain different components of a generalized medical instrumentation system, input transducer properties, and instrument characteristics. • Apply the knowledge of principles of various types of transducers and sensors including motion, displacement, force, pressure sensors to different medical applications. • Apply the knowledge of principles of various types of temperature sensors to different medical applications. • Apply the knowledge of the various biopotential electrodes for measuring different types of biopotentials. • Apply the principles of various chemical sensors for measuring concentration of biochemical analytes. • Explain the principles of various biosensors and their medical applications.	

Module	Contents	Hours
1.	**Introduction**: Generalized medical instrumentation system; General properties of input transducers; Static characteristics: Accuracy, precision, resolution, reproducibility, sensitivity, drift, hysteresis, linearity, input impedance and output impedance; Dynamic characteristics: Transfer functions, first order and second order systems, time delay; Design criteria.	**04**
2.	**Displacement, Motion, Force and Pressure Sensors and their Medical Applications**: Displacement measurement: Potentiometers, strain gauges, bridge circuits, inductive sensor – L.V.D.T., capacitive sensors; Acceleration and force measurement: Piezoelectric sensor, load cell; Pressure sensing elements: Diaphragms, bellows, bourdon tubes.	**08**
3.	**Temperature Sensors and their Medical Applications:** Temperature measurement: Thermistor, thermocouple, resistive temperature detector; IC-based temperature measurement; Radiation sensors: Thermal sensors, quantum sensors, and radiation thermometry.	**06**
4.	**Biopotential electrodes**: Electrode-electrolyte interface, half-cell potential, polarization, polarizable and non-polarizable electrodes, calomel electrode; Electrode circuit model, electrode-skin interface and motion artefacts; Body surface electrodes; Internal electrodes: Needle and wire electrodes (different types); Microelectrodes: Metal and supported metal micropipette (metal filled glass and glass micropipette) electrodes.	**06**
5.	**Chemical Sensors and their Medical Applications:** Blood gas and acid- base physiology; pH, Pco_2, Po_2 electrodes; ISFETs; Transcutaneous arterial O_2 and CO_2 tension monitoring. **Fiber optic Sensors and their Medical Applications**: Principle of fiber optics; Fiber optic sensor types - Temperature, chemical, and pressure.	**07**
6.	**Biosensors**: Types of biosensors - electrochemical biosensors, optical biosensors, piezoelectric biosensors; Biorecognition elements and their immobilization techniques; Medical applications of biosensors.	**08**

Books Recommended:

Text Books:

1. Medical Instrumentation-Application and Design, John G. Webster, Wiley India Private Limited.
2. Instrument Transducers: An Introduction to Their Performance and Design, Hermann K. P. Neubert, Oxford University Press.
3. Biomedical Sensors: Fundamentals and Applications, Harry N. Norton, Noyes Publications.
4. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamura and P. Ake Öberg, CRC Press.
5. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog, Prentice-Hall of India Pvt. Limited.
6. Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey, Smithers Rapra Technology.

Reference Books:

1. Principles of Applied Biomedical Instrumentation, L.A. Geddes and L.E. Baker, Wiley India Pvt Ltd.
2. Biomedical Instrumentation and Measurements, Leslie Cromwell, Erich A. Pfeiffer and Fred J. Wiebell, Prentice-Hall of India Pvt. Ltd.

3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Company.
4. Measurement Systems, Application and Design, Ernest O. Doeblin, McGraw Hill Higher Education.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, Springer Publishing Company.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S. C. Cobbold, John Wiley & Sons.

NPTEL/Swayam Course:

Course: Industrial Instrumentation by Prof. Alok Barua - IIT Kharagpur

https://nptel.ac.in/courses/108/105/108105064/

Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC304	Electronic circuit analysis and design (Abbreviated as ECAD)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC304	Electronic Circuit Analysis and Design (ECAD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC304	Electronic Circuit Analysis and Design	04
Course Objectives	• To understand transfer characteristics of semiconductor devices and to analyse basic application circuits. • To make learners aware about the mathematical models of BJT and its use in analysing the circuits. • To make the learners aware about different types of coupling and the concept of multistage amplifiers. • Learners will be able to design power amplifier. • To learn types and applications of MOSFET.	
Course Outcomes	Learner will be able to: • Explain the transfer characteristics in analysing the electronic circuits which use diode, BJT etc. • Explain equivalent circuits of BJT and apply them to analyse and design BJT based amplifier circuits • Apply the knowledge of mathematical model to analyse multistage amplifiers. • Design and analyse power amplifiers. • Apply the concept of transfer characteristics, D.C. load line, A.C. load line to analyse MOSFET amplifiers.	

Module	Contents	Hours
1.	**Basics of Diodes:** Construction, Working, Characteristics, Current Equation & Equivalent circuits of P-N Junction Diode as well as Zener Diode; Applications of Diode: Clipper & Clamper.	**06**
2.	**Basics & DC analysis of BJT:** Construction; Working and Characteristics of 3 different configurations of BJT; Quiescent point, DC load line, BJT Biasing techniques (Fixed, Self, Voltage Divider, Collector to base, Collector to base self) and BJT as a switch.	**10**
3.	**BJT as an Amplifier:** A.C. Equivalent Model: r_e model, h-parameter model (Exact and Approximate) and Hybrid-π model; A.C. Analysis (Using any one model): A.C. load line, A.C. analysis of CE, CB, CC amplifier configurations, Effects of R_S & $R_{L,}$ Low frequency and High frequency analysis of Single stage amplifiers; Design of single stage amplifier using BJT.	**10**
4.	**Multistage Amplifier:** Need of cascading; Types of coupling; D.C. and A.C. analysis of CS-CE cascade configuration, Cascode amplifier, Darlington amplifier**.**	**08**
5.	**Power Amplifiers:** Classes of Power amplifiers; Class-A Power Amplifiers (Direct coupled and Transformer coupled), Class-B Power Amplifiers, Crossover distortion, Harmonic distortion, Class-AB Push Pull and Complementary Symmetry Power amplifier, Class-C Power Amplifier, Class A and B/AB Power amplifier design, Heat Sinks and its design.	**08**
6.	**MOSFET:** Comparison of BJT & FET, Classification, Characteristics, Biasing of MOSFET, MOSFET as an amplifier & MOSFET as a switch.	**10**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Textbooks:
1. Electronics Circuit. Analysis & Design, 2nd ed., Donald A. Neamen, McGraw Hill, 2001
2. Electronics Devices & Circuits Theory, by by Robert L. Boylestad and Louis Nashelsky, Pearson Education.
3. Semiconductor Data Manual, BPB Publications.

Reference Books:
1. Electronic Principles, by Albert Paul Malvino 6th edition, McGraw Hill
2. Electronic Devices and Circuits, by Jacob Milliman McGraw Hill.
3. Electronic Design, by Martin Roden, Gordon L.Carpenter, William Wieseman, Fourth edition, Shroff Publishers & Distributors Pvt. Ltd..
4. Electronic Circuits Discrete and Integrated, by Donald Schilling & Charles Belove, Third edition, McGraw Hill.

NPTEL/Swayam Course:
Course: Analog Electronic Circuits by Prof. Pradip Mandal - IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105158/

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC305	Digital Electronics (Abbreviated as DE)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg							
BMC305	Digital Electronics (DE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC305	Digital Electronics	03
Course Objectives	• To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops. • Learner should be able to design various counters, registers and know their applications. • Learner should be able to design sequential circuits as a state machine.	
Course Outcomes	Learner will be able to: • Describe various number systems, logic gates and logic families. • Apply Boolean algebra, K-maps for Logic reduction and implementations in SOP and POS form • Develop combinational circuits such as code converter circuits, parity generator checker circuits and magnitude comparator circuits. Also, circuits using multiplexers, de-multiplexers, and decoders. • Design synchronous sequential circuits and asynchronous counters using flip flops • Design various registers using flip flops.	

Module	Contents	Hours
1.	**Fundamentals of Digital Design:** **Introduction:** Number system: Binary, Octal, Hexadecimal and other. Conversion from One system to another. **Binary Codes:** Weighted, Reflective, Sequential, Gray, Error detecting codes, Odd, Even parity, Hamming Codes etc. **Logic Gates and Families:** AND, OR, NOT, XOR, XNOR, operation NAND, NOR used of the universal gate for performing different operations. TTL and CMOS logic families.	**04**
2.	**Combinational Logic Design:** **Boolean Algebra**: Laws of Boolean algebra, De- Morgan's theorems, Relating a Truth Table to a Boolean Expression, Multilevel circuits. **Logic Reduction Techniques**: K-MAPS and their use in specifying Boolean Expressions, Prime-implicant, Minterm, Maxterm, SOP and POS Implementation. Implementation of logic function using universal gates. Application of gray code, Hazards in combinational circuits.	**08**
3.	**MSI Combinational Circuits:** **Elementary Designs:** Designing code converter circuits e.g. Binary to Gray, BCD to Seven Segments, Parity Generator and Parity Checker (3 bit). **Binary Arithmetic Circuits**: Binary Addition, Binary Subtraction (ones and twos complement), (Half & Full) Adders, (Half & Full) Subtractors, BCD adder, BCD-Subtractor (9's complement method), Serial adder, Multiplier, Magnitude Comparators, 7485 comparator, Arithmetic Logic Units. **Use of Multiplexers in Logic Design:** Multiplexer (ULM) Shannon's theorem. De-Multiplexers, Line decoders.	**11**
4.	**Fundamentals of Sequential Logic Circuits:** **Flip-Flops:** Comparison of Combinational & Sequential Circuits, Flip-Flops, SR, T, D, JK, Master Slave JK, Converting one Flip-Flop to another **Counters:** Modulus of a counter, Designing of synchronous and asynchronous counter using flip flop, Concept of drawing state transition diagram & state transition table. Minimum cost and minimum risk approach in design.	**08**
5.	**Sequential Circuit Designs:** State machine analysis, State machine design as Mealy and Moore machines, basic design of sequence detector.	**04**
6.	**Sequential Logic Designs:** **Registers:** Serial input serial output, serial input parallel output, Left Right shift register, Bidirectional shift register, Universal shift register. Ring Counter, Twisted Ring Counter, Sequence generator.	**04**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Modern Digital Electronics, by R.P.Jain Tata McGraw Hill, 1984
2. Digital Design,by M Morris Mono Prentice Hall International-1984.
3. Digital Principal and Applications, by Malvino& Leach, Tata McGraw Hill, 1991.
4. Digital Electronics, by Malvino, Tata McGraw Hill, 1997.
5. Digital Logic: Applications and Design,by John Yarbourugh Cengage Learning
6. Fundamentals of Digital Circuits,by A. Anand Kumar, Prentice-Hall of India Pvt.Ltd;
7. Digital Design: Principles & Practices, by John F. Wakerly, Prentice Hall

Reference Books:

1. Digital Electronics, by James Bignell& Robert Donovan, Delmar, Thomas Learning,
2. Logic Circuits,by Jog N.K, 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Introduction to Logic Design, by Alan b. Marcovitz McGraw Hill International 2002.

NPTEL/Swayam Course:

Course: 1. Digital Circuits by Prof. Santanu Chattopadhyay - IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105113/
https://swayam.gov.in/nd1_noc20_ee70/preview
Course: 2. Switching Circuits and Logic Design by Prof. Indranil Sengupta - IIT Kharagpur
https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-cs67/
https://swayam.gov.in/nd1_noc20_cs67/preview

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML301	Human Anatomy and Physiology for Engineers (HAPE)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML301	Human Anatomy and Physiology for Engineers (HAPE)	--	--	--	--	25	--	--	--	25

Course Code	Course Name	Credits
BML301	Human Anatomy and Physiology for Engineers	01
Course Objective	• To understand the anatomical structures of the human body and their relationship to each other. • To gain the knowledge of measurement of various physiological parameters of the human body.	
Course Outcome	The learner will be able to : • Demonstrate measurement of blood pressure using occlusive cuff method. • Apply blood cell counting principles for measuring blood composition. • Demonstrate the measurement of electrical activity of heart and the related parameters. • Demonstrate the measurement of various lung volumes and capacities. • Appropriately utilize laboratory equipment, such as microscopes, general lab ware, and virtual simulations. • Locate and identify anatomical structures.	

Syllabus: Same as that of BMC302, Human Anatomy and Physiology for Engineers.

List of Laboratory Experiments: (Any Seven)

1. To measure blood pressure using sphygmomanometer.
2. To find the total red blood cell count using pre-prepared slides.
3. To find the total white blood cell count using pre-prepared slides.
4. To study the conduction system of the heart.
5. To study the twelve lead electrode scheme and operation of the ECG Machine.
6. To record ECG and measure its various parameters (amplitude, intervals/segment).
7. To record lung volumes and capacities using a spirometer.
8. Visit to the anatomy department of a hospital to view specimens (cardiovascular & respiratory systems).
9. Visit to the anatomy department of a hospital to view specimen (alimentary & renal systems).
10. Visit to the anatomy department of a hospital to view specimen (nervous system).
11. Present a case study on a given disease/abnormality that requires medical instruments for diagnosis/treatment.
12. Present case a study on a given disease/abnormality that requires medical instruments for diagnosis/treatment.

Any other experiment/visit to the hospital/case study based on syllabus which will help learner to understand a topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub.)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body: Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int.)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper Collin Pub.)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

NPTEL/Swayam Course:

Course: Animal Physiology by Prof. Mainak Das - IIT Kanpur
https://nptel.ac.in/courses/102/104/102104058/
https://swayam.gov.in/nd1_noc20_bt42/preview

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML302	Medical Sensors (Abbreviated as MS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory								
		Internal Assessment			End Sem	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.						
BML302	Medical Sensors (Abbreviated as MS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML302	Medical Sensors	01
Course Objectives	• To analyse the transient response of a first-order system. • To measure displacement using various displacement sensors. • To measure pressure using a pressure sensor. • To measure force using a force sensor. • To measure temperature using various temperature sensors. • To measure pH of a solution using a pH electrode.	
Course Outcomes	The learner will be able to: • Analyse step response of a first-order system. • Demonstrate the measurement of displacement using various displacement sensors. • Demonstrate the measurement of force and pressure using a force sensor and a pressure sensor respectively. • Demonstrate the measurement of temperature using various temperature sensors. • Distinguish various biopotential electrodes. • Demonstrate the measurement of pH of a solution using a pH electrode.	

Syllabus: Same as that of BMC303 Medical Sensors.

List of Laboratory Experiments: (Any seven)

1. To study the transient response of a first-order system.
2. To study the resistance versus temperature characteristics of a thermistor.
3. To study the thermistor linearization technique.
4. To study the characteristics of a light dependent resister.
5. To study the principle and working of a thermocouple.
6. To study principle and working of L.V.D.T.
7. To study principle and working of a capacitive sensor.
8. To study principle and working of a strain gage sensor.
9. To study principle and working of a pressure sensor.
10. To study the principle and working of a force sensor.
11. To study the various biopotential electrodes.
12. To study the pH electrode.

Any other experiment/student presentation based on the syllabus which will help the learner to understand a topic/concept.

Books Recommended:

Text Books:

1. Medical Instrumentation-Application and Design, John G. Webster, Wiley India Private Limited.
2. Instrument Transducers: An Introduction to Their Performance and Design, Hermann K. P. Neubert, Oxford University Press.
3. Biomedical Sensors: Fundamentals and Applications, Harry N. Norton, Noyes Publications.
4. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamura and P. Ake Öberg, CRC Press.
5. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog, Prentice-Hall of India Pvt. Limited.
6. Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey, Smithers Rapra Technology.

Reference Books:

1. Principles of Applied Biomedical Instrumentation, L.A. Geddes and L.E. Baker, Wiley India Pvt Ltd.
2. Biomedical Instrumentation and Measurements, Leslie Cromwell, Erich A. Pfeiffer and Fred J. Wiebell, Prentice-Hall of India Pvt. Ltd.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Company.
4. Measurement Systems, Application and Design, Ernest O. Doeblin, McGraw Hill Higher Education.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, Springer Publishing Company.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S. C. Cobbold, John Wiley & Sons.

NPTEL/Swayam Course:

Course: Industrial Instrumentation by Prof. Alok Barua - IIT Kharagpur

https://nptel.ac.in/courses/108/105/108105064/

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML303	Electronic Circuit Analysis and Design Lab (ECAD Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML303	Electronic Circuit Analysis and Design Lab (ECAD Lab)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML303	Electronic Circuit Analysis and Design Lab	01
Course Objective	• To practically verify characteristics of different electronic components like diodes, BJT, MOSFET etc • To practically verify outputs of few applications of diodes, BJT, MOSFET. • To design and implement small signal amplifier.	
Course Outcome	Learner will be able to: • Explain the transfer characteristics of basic semiconductor devices. • Design and verify the outputs of various electronic circuits such as clipper, clampers etc using bread boards and various lab equipments. • Design amplifier circuits and plot its frequency response.	

Syllabus: Same as that of BMC304 Electronic Circuit Analysis and Design.

List of Laboratory Experiments: (Any Eight)

1. To verify semiconductor diode and Zener diode characteristics.
2. To implement various clipper circuits and verify output.
3. To implement various clamper circuits and verify output.
4. To study line regulation and load regulation of voltage regulator using Zener diode.
5. To verify input and output characteristics of BJT.
6. To implement a switch using BJT.
7. To implementation different biasing circuit of BJT
8. To design and implement CE amplifier.
9. To study frequency response of CE amplifier.
10. To verify input and output characteristics of MOSFET.
11. To implementation different biasing circuit of MOSFET
12. To Study frequency response of an MOSFET amplifier.

Any other experiment based on syllabus can be included in the term work which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Textbooks:

1. Electronics Circuit. Analysis & Design, 2nd ed., Donald A. Neamen, McGraw Hill, 2001
2. Electronics Devices & Circuits Theory, by by Robert L. Boylestad and Louis Nashelsky, Pearson Education.
3. Semiconductor Data Manual, BPB Publications.

Reference Books:

1. Electronic Principles, by Albert Paul Malvino 6th edition, McGraw Hill
2. Electronic Devices and Circuits, by Jacob Milliman McGraw Hill.
3. Electronic Design, by Martin Roden, Gordon L.Carpenter, William Wieseman , Fourth edition, Shroff Publishers & Distributors Pvt. Ltd..
4. Electronic Circuits Discrete and Integrated, by Donald Schilling & Charles Belove, Third edition, McGraw Hill.

NPTEL/Swayam Course:

Course: Analog Electronic Circuits by Prof. Pradip Mandal - IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105158/

Practical exam consists of performance of any one practical from the conducted experiments within the semester and oral based on entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML304	Electronics Lab (Skill Based Lab)	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML304	Electronics Lab (Skill Based Lab)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML304	Electronics Lab (Skill Based Lab)	02
Course Objective	• To design and implement voltage regulator circuits. • To design and implement digital circuits. • To learn skills of soldering. • To learn simulation of circuits using one of the simulation software.	
Course Outcome	Learner will be able to: • Design and implement analog and digital electronic circuits on bread board and verify the outputs. • Learn one of the tools for simulating different circuits. • Know the limitations of ideal environment of simulations and also importance of simulation in designing the circuits. • Learn soldering skills for implementing the circuits on PCB.	

List of experiments from Analog electronics:

Skill 1-Soldering the components on PCB (Any 4)

1. Implement diode as full-wave rectifier using centre tap transformer.
2. Implement diode as full-wave rectifier using bridge circuit.
3. Use of Filter components with rectifier circuit.
4. Implement voltage regulators using IC 79XXand/or IC 78XX
5. Implement voltage regulators using IC 317/IC 723
6. Implement of logic gates using diodes.

Skill 2-Simulations using simulation software like Multisim, Pspice etc (Any 4)

1. Simulate CASCODE amplifier.
2. Simulate Darlington amplifier.
3. Simulate power Amplifier
4. Simulate DIAC for transfer characteristics.
5. Simulate TRIAC for transfer characteristics.
6. Simulate UJT for transfer characteristics.

List of experiments from Digital Electronics (Perform using Breadboard or Logisim S/W etc):

(Any 8)

1. A step in space vehicle checkout depends on FOUR sensors S1, S2, S3 and S4. Every circuit is working properly if sensor S1 and at least two of the other three sensors are at logic 1. Implement the system using NAND gates only, the output is connected to a red LED which must glow if the circuit is not working properly and the output is connected to a green LED which must glow if the circuit is working properly.
2. To design binary to gray code converter and gray to binary converter.

3. To design parity generator and parity checker circuits.
4. To design adder and subtractor circuits.
5. To design various circuits using multiplexers.
6. To design various circuits using de-multiplexer.
7. To design Asynchronous counter.
8. To design decade counter
9. To design Synchronous counter.
10. To implement shift register and ring counter using MSI shift register.
11. To implement Moore/ Mealy machine.
12. A given finite state machine has an input W and output Z. During four consecutive clock pulses a sequence of four values of W signal is applied. Design a machine that produces Z = 1 when it detects either of sequence W: 0010 or W: 1110 otherwise Z=0. After the fourth clock pulse the machine has to be again in the reset state ready for next sequence.

Any other experiment based on syllabus can be included in the term work which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments from Analog electronics and 8 experiments from digital electronics.

The distribution of marks for term work shall be as follows:

Laboratory work (Lab work and journal):10 Marks
Soldering skills :05 Marks
Simulation skills :05 marks
Attendance :05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Op-Amps and linear integrated circuits – Ramakant Gayakwad, Prentice Hall
2. Electronics Devices & Circuits, by Boylestad Robert L., Louis Nashelsky, Pearson Education.
3. Modern Digital Electronics, by R.P.Jain, Tata McGraw Hill, 1984
4. Digital Design, M Morris Mono, Prentice Hall International-1984.

Reference Books:

1. Electronic Principles, by Albert Paul Malvino, 6/e, McGraw Hill
2. Semiconductor Data Manual, BPB Publications.
3. Electronic design, by Martin Roden, Gordon L. Carpenter, William Wieseman Fourth edition, Shroff Publishers &Distributors Pvt. Ltd.
4. Digital Design, by M Morris Mono Prentice Hall International 1984

Practical exam consists of performance of any one practical from digital electronics experiments conducted within the semester and oral based on digital electronics syllabus.

Course code	Course Name	Credits
BMM301	Mini Project - 1 A	02

Course Code	Course Name	Credits
BMM301	Mini Project – 1 A	02
Course Objective	• To acquaint with the process of identifying the needs and converting it into the problem. • To familiarize the process of solving the problem in a group. • To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. • To inculcate the process of self-learning and research.	
Course Outcome	Learner will be able to: • Identify problems based on societal /research needs. • Apply Knowledge and skill to solve societal problems in a group. • Develop interpersonal skills to work as member of a group or leader. • Draw the proper inferences from available results through theoretical/ experimental/simulations. • Analyse the impact of solutions in societal and environmental context for sustainable development. • Use standard norms of engineering practices • Excel in written and oral communication. • Demonstrate capabilities of self-learning in a group, which leads to life long learning. • Demonstrate project management principles during project work.	

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems

- Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communicate

Semester - IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract.	Tut.	Total
BMC401	Engineering Mathematics-IV	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Avg of Test 1 & 2					
BMC401	Engineering Mathematics-IV	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Course Code	Course Name	Credits
BMC401	Engineering Mathematics – IV	04
Course Objectives	• To study the line and contour integrals and expansion of complex valued function in a power series. • To understand the basic techniques of statistics for data analysis, Machine learning and AI. • To study the probability distributions and expectations. • To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems. • To familiarize with the concepts of Quadratic forms and Singular value decomposition. • To learn the concepts of Calculus of Variations.	
Course Outcomes	On successful completion of course, learner will be able to: • Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. • Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI. • Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. • Apply the concept of vector spaces and orthogonalization process in Engineering Problems. • Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications. • Find the extremals of the functional using the concept of Calculus of variation.	

Module	Detailed Contents	Hrs.
01	**Module: Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations ,Z- Transform.	7
02	**Module: Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Module: Probability Distributions** 2.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Module: Linear Algebra: Vector Spaces:-** 4.1 Vectors in n-dimensional vector space, norm, dot product, The CauchySchwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence and Independence, QR decomposition.	6
05	**Module: Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7
06	**Module: Calculus of Variations:** 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-** Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action , Several dependent variables.	6

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of marks for term work shall be as follows:

Class Tutorials on entire syllabus	: 10 Marks
Mini project	: 10 Marks
Attendance (Theory and Tutorial)	: 5 Marks

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC402	Integrated Circuit Design (Abbreviated as ICD)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC402	Integrated Circuit Design (Abbreviated as ICD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC402	Integrated Circuit Design	03
Course Objectives	• To provide concepts of operational amplifier (Op-Amp) with their applications and design methodology. • To cover analysis of circuits using various ICs. • To design and develop various circuits for biomedical applications and to develop analytical thinking of students.	
Course Outcomes	Learner will be able to: • Demonstrate basics of operational amplifiers. • Analyse different types of Op-Amp based circuits. • Analyse and design operational amplifier to perform mathematical operations. • Design operational amplifier based oscillators. • Learn various waveform generation ICs and their applications to use effectively in projects. • Apply the knowledge of various special function ICs and special purpose diodes for designing practical applications.	

Module	Contents	Hours
1.	**Introduction to Operational Amplifier (Op-Amp):** Introduction to Differential Amplifier; Introduction to an Ideal Operational Amplifier, Block Diagram, DC & AC Characteristics and Equivalent circuit of Op-amp; Op-amp IC 741 characteristics, frequency response and concept of virtual ground.	**05**
2.	**Linear Application of Op-Amp:** Adder, Subtractor /differential Amplifier, Voltage follower, Integrator (Ideal and practical), Differentiator (Ideal and practical), Instrumentation amplifier and Instrumentation amplifier IC (AD620); Voltage to Current and Current to Voltage converters.	**05**
3.	**Non-Linear Applications of operational Amplifier:** Voltage comparators, zero crossing detector and Schmitt Trigger (Regenerative comparator); Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Peak to Peak detector and Generalized Impedance Convertor; Introduction to additional Op-Amp ICs and their features: CA3140E, TL081CN, TL061CP, TL071CP, MC33171N, TL0xx, MCP601 and OPA602.	**10**
4.	**Oscillators using Operational Amplifier:** Concepts of feedback, types of feedback and various topologies of negative feedback; Concepts of Oscillation and Barkhausen's criteria for an oscillator; Types of oscillators: RC Phase shift Oscillator, Wien Bridge oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator and Clapp Oscillator (For all the above oscillators; working, Frequency of oscillation, condition for sustained oscillation and design of each oscillator).	**09**
5.	**Special Function ICs - 1:** IC 555 Functional Block diagram and Circuit diagram; IC 555 in Astable Multivibrator(AMV) functional diagram, circuit diagram with applications; IC 555 in Monostable Multivibrator (MMV) functional diagram, circuit diagram with applications.	**05**
6.	**Special Function ICs – 2:** Function Generator (IC 8038 or equivalent) Circuit diagram and its applications; VCO (IC 566) Circuit diagram and applications; F-V convertors and V-F convertors; Circuit diagram and its applications; Introduction to PLL	**05**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Textbooks:

1. Integrated Circuits K.R. Botkar
2. Design with Operational Amplifiers and Analog Integrated Circuits, by Sergio Franco, McGraw Hill, 2002
3. Op-Amps and linear integrated circuits by Ramakant. Gayakwad Prentice Hall
4. Linear Integrated Circuits, by D Choudhury Roy, New Age International Publishers

Reference Books:

1. Analog Integrated Circuit Design, by, Tony Chan Carusone, David Johns, Kenneth William Martin Wiley, 2012
2. Op-amps and linear integrated circuits, Theory and Applications- James Fiore, Delmar Thomson Learning, 2001

NPTEL/Swayam Link:
Course: Integrated Circuits, MOSFETs, Op-Amps and their Applications by Prof. Hardik Jeetendra Pandya - IISc Bangalore
https://nptel.ac.in/courses/108/108/108108111/

Theory Examination:

5. Question paper will comprise of 6 questions, each carrying 20 marks.
6. Total four questions need to be solved.
7. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
8. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC403	Principles Control System (Abbreviated as PCS)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC403	Principles Control System (Abbreviated as PCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC403	Principles of Control Systems	3
Course Objectives	• To make the learner aware of fundamental concepts of Control systems and mathematical modelling of the system. • To make learner study the state variable representation of control system • To make learner know the concept of time response and frequency response of the system. • The learner should be able to do stability analysis of the system and aware of PID controllers	
Course Outcomes	• To describe basic concepts of control system such as open loop, closed loop, feedback and feed forward systems • To develop the mathematical model of different type of systems • To analyze systems using state space techniques • To analyse stability in time domain using root locus and BIBO stability • To examine correlation between stability analysis of systems in time and frequency domain • To analyse effect of PID controller in control design	

Module No.	Contents	Hours
1	**Introduction to Control System Analysis:** Open loop and closed loop systems; Feedback and feed forward control structure; Examples of control systems.	03
2	**Mathematical Modelling of Systems:** Transfer function models of systems**,** Models of electrical systems, Block diagram reduction; Signal flow graph and the Mason's gain rule. Standard test signals; Transient and steady state behaviour of first and second order systems; Type and order of feedback control systems and steady state error analysis	08
3	**State Variable Models :** State variable models of systems. Concept of state transition matrix; Properties of state transition matrix; Solution of homogeneous systems. Concept of controllability and observability; Controllability & Observability analysis of LTI systems using Kalman approach.	08
4	**Stability Analysis in Time Domain:** Concept of absolute, Relative and robust stability; Routh Hurwitz stability criterion; Root-locus concepts; General rules for constructing root-locus; Root locus analysis of control systems.	08
5	**Stability Analysis in Frequency Domain:** Frequency domain specifications; Response peak and peak resonating frequency; Relationship between time and frequency domain of systems; Stability margins. Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	09
6	**Concept of feedback controllers:** Concept of proportional, PI and PID Controllers	03

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Modern Control Engineering : D.Roy Choudhury, PHI
2. Modem Control Engineering : K. Ogata , PHI
3. Control Systems Engineering: I.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.
4. Control Systems: Principle and design, by M. Gopal Tata McGraw Hill, First Edition, 1998
5. Automatic Control Systems – Kuo
6. Modern Control System, Pearson, Richard C. Dorf and Robert H. Bishop, Eleventh Edition, 2013.

Reference Books:

1. Modern Control Technology, Components & Systems – Kilian
2. Analog And Digital Control System Design – Chen
3. Linear Control System Analysis and Design – Sheldon
4. Schaum's Outline of Theory and Problems - Schaum's
5. Automated Continuous Process Control and Multivariable Control – Smith
6. Robust Control System Design State Space Method – Tsui

NPTEL /Swayam Link:
Course 1: Control systems by Prof. C.S.Shankar Ram - IIT Madras
https://nptel.ac.in/courses/107/106/107106081/
https://swayam.gov.in/nd1_noc20_ee90/preview
Course 2: Control Engineering by Prof. Ramkrishna Pasumarthy - IIT Madras
https://nptel.ac.in/courses/108/106/108106098/
https://swayam.gov.in/nd1_noc20_ee62/preview

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC404	Medical Imaging-I (Abbreviated as MI-I)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dura tion (hrs)					
		Test 1	Test 2	Avg.							
BMC404	Medical Imaging-I (Abbreviate as MI-I)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC404	Medical Imaging-I	03
Course Objectives	• To familiarize the learners with the various Imaging modalities in medicine, their operating principles and quality control aspects. • To keep the learners abreast with the technological developments in the field of Medical Imaging.	
Course Outcomes	Learner will be able to: • Discuss different parts of a X-Ray Equipment and outline process of X-Ray Interaction with matter. • Explain concepts of Radiography techniques such as Computed Radiography (CR), Digital Radiography (DR) and Mammography with focus on its clinical applications. • Explain working principle of Fluoroscopic Imaging and Digital Subtraction Angiography and outline its clinical applications. • Describe system configuration of Computed Tomography, Apply CT Image Reconstruction Algorithms and enlist its clinical applications. • Highlight the key advancements in CT Technology and demonstrate its application in area of Clinical angiography and Cardiac CT	

Module	Contents	Hours
1.	**X- Ray Imaging:** Properties of X-Rays, Production of X-Rays, X-Ray interaction with matter, Attenuation of X-Rays. Total Radiographic System: X – Ray tubes, Rating of X-Ray tubes, X-Ray generators, Filters, Grids, Beam Restrictors, Control Panel and X-Ray Films.	**12**
2.	**Radiography Techniques & Applications:** Principle and working of Computed Radiography, Digital Radiography and Mammography with its clinical applications.	**06**
3.	**Fluoroscopic Imaging:** X-Ray Image Intensifier, Principle and Working of C-Arm, Digital Subtraction Angiography and its clinical applications.	**04**
4.	**Principle of Computed Tomography:** Scanner Configurations/Generations, CT System: Scanning unit(gantry), Detectors, CT Number, Data Acquisition System. Spiral CT: Technology and clinical applications, CT artifacts and Clinical applications of CT	**08**
5.	**CT Reconstruction Techniques**: Radon Transform, Iterative, Filtered Back Projection and Fourier reconstruction.	**04**
6.	**Advancements in CT:** Multi-Detector Computed Tomography (MDCT), Flat Panel Detectors, Contrast agents in CT, CT-Angiography & Cardiac CT.	**05**

Internal Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Textbooks:

1. Christensen's Physics of Diagnostic Radiology: Thomas Curry, James Dowdey, Robert Murry (Publisher- Lea & Febiger)
2. Medical Imaging Physics: William R. Hendee (Publisher- Wiley-Blackwell)
3. The Physics of Diagnostic Imaging: David Dowsett (Publisher- CRC Press)

Reference Books:

1. Biomedical Technology and Devices: James Moore, Duncan Maitland (Publisher- CRC Press)
2. The Biomedical Engineering Handbook: Ed. Joseph D. Bronzino (Publisher-CRC Press LLC)
3. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Links:
Course 1: *Introduction to Biomedical Imaging*
https://www.edx.org/course/introduction-to-biomedical-imaging
Course 2: *Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications*
https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC405	Biomaterials and Artificial Organs (Abbreviated as BMAO)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dur-ation (hrs)					
		Test 1	Test 2	Avg.							
BMC405	Biomaterials and Artificial Organs (Abbreviated as BMAO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC405	Biomaterials and Artificial Organs	03
Course Objectives	• To understand the fundamentals of biomaterials used for manufacturing implants that has wide application in healthcare industry. • To understand design considerations and materials used for manufacturing of various artificial organs.	
Course Outcomes	Learners will be able to • Classify various biomaterials and select biomaterials for specific application • Explain biological, mechanical and physio-chemical tests conducted on biomaterials before implantation in the human body. • Explain properties and applications of metals and ceramic biomaterials. • Explain properties and applications of polymeric, degradable and composite biomaterials. • Explain design aspects and materials used in the fabrication of artificial organs.	

Module	Contents	Hours
1.	**Introduction to Biomaterials and Surface Properties of Biomaterials:** Introduction of biomaterials: Classification of biomaterials, general applications; Corrosion and wear of biomaterials; Biocompatibility**:** Definition, interaction of tissues with biomaterials; Surface properties of biomaterials**;** Surface characterization techniques**:** Electron **s**pectroscopy for chemical analysis (ESCA), secondary ion mass spectrometry (SIMS), infrared spectroscopy, contact angle method.	**06**
2.	**Testing of Biomaterials:** Mechanical Testing; Physiochemical Testing; Biological Testing: In-vitro testing, In-vivo testing of Biomaterials.	**06**
3.	**Metallic Biomaterials:** Properties, applications and biocompatibility of stainless steel, titanium, titanium based alloys and cobalt – chromium alloys in fabrication of bio-devices and implants.	**04**
4.	**Ceramic Biomaterials:** Classification of ceramic biomaterials; Properties, applications and biocompatibility of alumina, zirconia, bioglass, calcium phosphate and tricalcium phosphate in fabrication of biodevices and implants.	**04**
5.	**Polymeric Biomaterials:** Classification of polymeric biomaterials, Thermoplastic and Thermosetting plastics; Properties and applications of polyurethanes, PTFE, polyethylene, polypropylene, polyacrylates, PMMA, PHEMA, hydrogel, silicone rubber, degradable polymeric biomaterials (PGA and PLA) and biopolymer in fabrication of biodevices and implants. **Composite Biomaterials:** Classification, properties, and applications of composite biomaterials in fabrication of biodevices and implants.	**09**
6.	**Artificial Organs:** Design considerations and biomaterials involved in development of artificial heart and cardiac assist devices, heart valves, vascular grafts, peritoneal dialysis, artificial lungs, artificial liver, artificial pancreas, artificial blood, artificial skin; 3D bioprinting for manufacturing of artificial skin, cornea, collagen.	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundaments of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine: Ratner & Hoffmann (Elsevier Publications)
4. The Biomedical Engineering HandBook: Ed. Joseph D. Bronzino (CRC Press LLC)
5. Artificial Organs: Gerald E. Miller (Morgan and Claypool)
6. 3D Printing in Medicine: Deepak M Kalaskar (Woodhead Publishing)

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II Part – B: Applications Vol. I, II. (Marcel Dekkar Pub)
3. Design Engineering on Biomaterials for medical devices: David Hill (John Willey Publication)
4. Biological Performance of Materials, 2nd Edition – Jonathan Black (Marcel Dekker Inc.)

NPTEL/Swayam Links:
Course: Medical Biomaterials by Prof. Mukesh Doble - IIT Madras
https://nptel.ac.in/courses/102/106/102106057/

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML401	Integrated Circuit Design Lab (ICD Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML401	Integrated Circuit Design Lab (ICD Lab)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML401	Integrated Circuit Design Lab	01
Course Objective	• To study op-amp parameters and understand the data sheet. • To provide designing methodologies for basic circuits like amplifiers, filters, oscillators etc. using operational amplifiers. • To implement the circuits on bread boards for verifying the outputs and obtain frequency response.	
Course Outcome	Learner will be able to: • Read the data sheet of different ICs, compare the parameters to select appropriate IC. • To design and implement various building blocks of different biomedical instruments.	

Syllabus: Same as that of BMC403 Linear Integrated Circuits

List of Laboratory Experiments: (Any seven)

1. To study op-amp parameters.
2. To design and verify outputs of inverting amplifier, noninverting amplifier and voltage follower.
3. Design and verify the outputs of adder and subtractor.
4. To design and verify output of instrumentation amplifier.
5. To study frequency response of an integrator
6. To study frequency response of differentiator.
7. To study peak detector circuit.
8. To study half wave rectifier and full wave rectifier.
9. To study RC-phase shift oscillator.
10. To study Wein bridge oscillator.
11. To study comparators and zero crossing detector.
12. To design and study band pass filter using op-amp
13. To design and study notch filter.
14. To study monostable multivibrator using IC 555
15. To study astable multivibrator using IC555
16. To verify outputs of IC 8038

Any other experiment based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 10 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Textbooks:

1. Integrated Circuits K.R. Botkar
2. Design with Operational Amplifiers and Analog Integrated Circuits, by Sergio Franco, McGraw Hill, 2002
3. Op-Amps and linear integrated circuits by Ramakant. Gayakwad Prentice Hall
4. Linear Integrated Circuits, by D Choudhury Roy, New Age International Publishers

Reference Books:

1. Analog Integrated Circuit Design, by, Tony Chan Carusone, David Johns, Kenneth William Martin Wiley, 2012
2. Op-amps and linear integrated circuits, Theory and Applications- James Fiore, Delmar Thomson Learning, 2001

NPTEL/Swayam Link:

Course: Integrated Circuits, MOSFETs, Op-Amps and their Applications by Prof. Hardik Jeetendra Pandya - IISc Bangalore
https://nptel.ac.in/courses/108/108/108108111/

Practical exam consists of performance of any one practical from the conducted experiments within the semester and oral based on entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML402	Principles of Control Systems Lab (PCS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML402	Principles of Control Systems Lab (PCS)	--	--	--	--	25	--	--	--	25

Course Code	Course Name	Credits
BML402	Principles of Control Systems Lab	01
Course Objectives	• To make the learner aware of fundamental concepts of Control systems and mathematical modelling of the system. • To make learner study the state variable representation of control system • To make learner know the concept of time response and frequency response of the system. • The learner should be able to do stability analysis of the system and aware of PID controllers	
Course Outcomes	• To describe basic concepts of control system such as open loop, closed loop, feedback and feed forward systems • To develop the mathematical model of different type of systems • To analyse systems using state space techniques • To analyse stability in time domain using root locus and BIBO stability • To examine correlation between stability analysis of systems in time and frequency domain • To analyse effect of PID controller in control design	

List of Experiments: Any 7

1. Time response of first and second order RLC Circuits and systems
2. Frequency response of first and second order system
3. Plotting transient response by varying damping ratio using MATLAB/SCILAB
4. Type of a system and error coefficients
5. Design of standard test signal generators
6. Effect of adding Poles/Zeros in transient response and stability using MATLAB/SCILAB
7. Plot of Root locus using MATLAB/SCILAB

8. To determine frequency response of a second order system and evaluation of frequency domain specifications.
9. Frequency response of Lag and lead compensators
10. Bode Plot and stability using MATLAB/SCILAB
11. Checking Controllability and observability using MATLAB/SCILAB
12. Transient response/Solution of state equation of state space model using MATLAB/SCILAB
13. To study the effect of P, PI, PD and PID controller on step response of a feedback control system
14. PID Controller using SIMULINK

Students can perform any other experiment/Mini project based on the theory syllabus

Assessment:

***Term Work*:**

Term work shall consist of minimum 7experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments performance): 10 Marks

Laboratory work (Journal/Mini project): 10 Marks

Attendance :5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Books Recommended:

Text Books:

1. Modern Control Engineering : D.Roy Choudhury, PHI
2. Modem Control Engineering : K. Ogata , PHI
3. Control Systems Engineering: I.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.
4. Control Systems: Principle and design, by M. Gopal Tata McGraw Hill, First Edition, 1998
5. Automatic Control Systems – Kuo
6. Modern Control System, by Richard C. Dorf and Robert H. Bishop Pearson, Eleventh Edition, 2013.

Reference Books:

1. Modern Control Technology, Components & Systems – Kilian
2. Analog And Digital Control System Design – Chen
3. Linear Control System Analysis and Design – Sheldon
4. Schaum's Outline of Theory and Problems - Schaum's
5. Automated Continuous Process Control and Multivariable Control – Smith
6. Robust Control System Design State Space Method – Tsui

NPTEL /Swayam Link:

Course 1: Control systems by Prof. C.S.Shankar Ram - IIT Madras

https://nptel.ac.in/courses/107/106/107106081/

https://swayam.gov.in/nd1_noc20_ee90/preview

Course 2: Control Engineering by Prof. Ramkrishna Pasumarthy - IIT Madras

https://nptel.ac.in/courses/108/106/108106098/

https://swayam.gov.in/nd1_noc20_ee62/preview

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML403	Medical Imaging-I (Abbreviated as MI-I)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Dura tion (hrs)	Term work	Pract	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BML403	Medical Imaging-I (Abbreviated as MI-I)	--	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML403	Medical Imaging-I	01
Course Objectives	• To familiarize the learners with the various Imaging modalities in medicine, their operating principles and quality control aspects. • To keep the learners abreast with the technological developments in the field of Medical Imaging.	
Course Outcomes	Learner will be able to: • Discuss different parts of a X-Ray Equipment and outline process of X-Ray Interaction with matter. • Explain concepts of Radiography techniques such as Computed Radiography (CR), Digital Radiography (DR) and Mammography with focus on its clinical applications. • Explain working principle of Fluoroscopic Imaging and Digital Subtraction Angiography and outline its clinical applications. • Describe system configuration of Computed Tomography, Apply CT Image Reconstruction Algorithms and enlist its clinical applications. • Highlight the key advancements in CT Technology and demonstrate its application in area of Clinical angiography and Cardiac CT	

Syllabus: Same as that of BMC404 Medical Imaging – I (Abbreviated as MI-I)

Suggested List of Laboratory Experiments (Any Seven)

1. Study of X-Ray tube & Tube Housing
2. Prototype of X-Ray Generator Circuits
3. Design of X-Ray Timer
4. Comparative study of modern X-Ray machines manufactured by different companies
5. Simulation of Digital Subtraction Angiography using MATLAB
6. Comparative study of CT Machines manufactured by different companies
7. Case study on any disease/abnormality which require imaging modality for diagnosis
8. To perform CT windowing on an Image using MATLAB
9. To perform back projection on an Image using MATLAB
10. To generate pseudo colour image using MATLAB
11. Hospital Visit may be conducted to Radiology Department (Report by student is expected)
12. Technical paper review on the advanced topic (Report by student is expected)
13. Seminar talk by experts from industries (Report by student is expected)

Any other experiment based on syllabus which will help students to understand topic/concept.

Mandatory Activity: Group Presentations on the Latest Technology and Improvements in Medical Imaging (Report by student is expected)

Assessment:

Term Work:

Laboratory work shall consist of minimum 7 experiments. The distribution of marks for term work shall be as follows:
Laboratory work (Experiments & Journal): 10 Marks
Assignments: 05 Marks
Presentation: 05 Marks
Attendance: 05 Marks
Total: 25Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Textbooks:

1. Christensen's Physics of Diagnostic Radiology: Thomas Curry, James Dowdey, Robert Murry (Publisher- Lea & Febiger)
2. Medical Imaging Physics: William R. Hendee (Publisher- Wiley-Blackwell)
3. The Physics of Diagnostic Imaging: David Dowsett (Publisher- CRC Press)

Reference Books:

1. Biomedical Technology and Devices: James Moore, Duncan Maitland (Publisher- CRC Press)
2. The Biomedical Engineering Handbook: Ed. Joseph D. Bronzino (Publisher-CRC Press LLC)
3. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML404	Computing Lab (Skill Based Lab)	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML404	Computing Lab (Skill Based Lab)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML404	Computing Lab (Skill Based Lab)	02
Course Objective	• To understand basic concepts of Python programming language. • To understand decision controls and functions • To understand the utilization of various libraries in Python	
Course Outcome	Learner will be able to: • Describe Numbers, Strings, Lists, Tuples, Dictionaries, Array and Math functions in Python • Express different Decision Making statements and Functions • Illustrate different file handling operations • Interpret object oriented programming in Python • Develop proficiency in handling Python libraries	

Module	Contents	Hours
1	**Introduction to Python** Installation and resources; Introduction of the Python object types: Numbers, Strings, Lists, Tuples, Dictionaries, Arrays; Numeric types; Assignments; Expressions; Print statements and formats.	**08**
2	**Decision Control Statements and Functions:** if and else statement, if-elif-else statement, Loop Statement: While loops, for loops, Break, Continue, and Pass, Functions: Defining and calling functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions.	**10**
3	**Files Handling:** Types of Files in Python, Opening a File, Closing a File. Writing Text Files, Knowing Whether a File Exists or Not, Working with Binary Files, Appending Text to a File, Reading Text Files, File Exceptions, The with Statement	**10**
4	**Object Oriented Programming:** Introduction to OOP: Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes; Inheritance; Constructors; Exception handling.	**08**
5	**Numpy, Matplotlib:** Introduction to Numpy: Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy. Introduction to Matplotlib library: Line properties, Plots and subplots, Types of Plots.	**10**
6	**Pandas, Seaborn:** Introduction to Pandas: Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation. Introduction to Seaborn.	**06**

List of experiments

1. Write python programs to understand expressions, variables, quotes, basic math operation.
2. Write a Python program to remove elements from the list.
3. Write a Python program to understand concept of tuple and dictionary. (creating, accessing elements and deleting elements)
4. Write a Python program to demonstrate if-else, for loop and while loop.
5. Write a Python program to demonstrate continue, break and pass statement.
6. Write a Python program to read, write and copy write from a file.
7. Write a Python program to perform different file handling functions
8. Write a Python program to demonstrate working of classes and objects and members.
9. Write a Python program to demonstrate class method & static method.
10. Write a Python program to demonstrate constructors.
11. Write a Python program to demonstrate inheritance.
12. Write a Python program to demonstrate sorting in numpy.
13. Write a Python program to perform merging, joining and concatenating using Panda.
14. Write a Python program to plot the data using matplotlib

Any other experiment based on syllabus which will help students to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 12 experiments.

The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education
2. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
3. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).
4. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher August 2015.
5. Yashavant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1 edition (8 July 2019).
6. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication

Reference Books:

1. Python Cookbook: Recipes for Mastering Python 3,by David Beazley, Brian K. Jones O'Reilly Media; 3 edition (10 May 2013).
2. Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, by Zed A. Shaw Addison Wesley; 3 edition (1 October 2013).
3. Introduction to Machine Learning with Python, by Andreas C. Mueller O′Reilly; 1 edition (7 October 2016)
4. Python Crash Course A hands-on, Project Based Introduction to programming, by Eric Matthes No Starch Press; 1 edition (8 December 2015).
5. Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application, by Bhaskar Chaudhary Packt Publishing (November 30, 2015)
6. Head First Python, by Paul Barry O′Reilly; 2 edition (16 December 2016)

NPTEL/Swayam Links:

Course: Programming, Data Structures and Algorithms using Python by Prof. Madhavan Mukund -IIT Madras
https://nptel.ac.in/courses/106/106/106106145/

Course code	Course Name	Credits
BMM401	Mini Project - 1 B	02

Course Code	Course Name	Credits
BMM401	Mini Project – 1 B	02
Course Objective	• To acquaint with the process of identifying the needs and converting it into the problem. • To familiarize the process of solving the problem in a group. • To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. • To inculcate the process of self-learning and research.	
Course Outcome	Learner will be able to: • Identify problems based on societal /research needs. • Apply Knowledge and skill to solve societal problems in a group. • Develop interpersonal skills to work as member of a group or leader. • Draw the proper inferences from available results through theoretical/ experimental/simulations. • Analyse the impact of solutions in societal and environmental context for sustainable development. • Use standard norms of engineering practices • Excel in written and oral communication. • Demonstrate capabilities of self-learning in a group, which leads to life long learning. • Demonstrate project management principles during project work.	

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems

- Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

AC 05/05/2018
Item No. 4.57

UNIVERSITY OF MUMBAI

Revised Syllabus for the

TE Biomedical Engineering
(Third Year - Semester V and VI)

(As per Choice Based Credit and Grading System
with effect from the academic year 2018–2019

Program Structure for
TE Biomedical Engineering
University of Mumbai
(With effect from academic year 2018 - 19)

Scheme for Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC501	Diagnostic & Therapeutic Instruments	04	----	----	04	----	----	04
BMC502	Analog and Digital Circuit Design	04	----	----	04	----	----	04
BMC503	Principles of Communication Engineering	04	----	----	04	----	----	04
BMC504	Biomedical Digital Signal Processing	04	----	----	04	----	----	04
BMDLO501X	Department Level Optional Course – I	04	----	----	04	----	----	04
BML501	Business Communication and Ethics	----	02*+02	----	----	02	----	02
BML502	Diagnostic and Therapeutic Instruments	----	02	----	----	01	----	01
BML503	Integrated and Communication Circuit Design	----	02	----	----	01	----	01
BML504	Biomedical Digital Signal Processing	----	02	----	----	01	----	01
BMDLL501X	Department Level Optional Course Laboratory – I	----	02	----	----	01	----	01
Total		20	12	----	20	06	----	26

***2 hrs theory shall be taught to the entire class.**

Examination Scheme for Semester V

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC501	Diagnostic & Therapeutic Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC502	Analog and Digital Circuit Design	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC503	Principles of Communication Engineering	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC504	Biomedical Digital Signal Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 501X	Department Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML501	Business Communication and Ethics	---	---	---	---	50	20	---	---	---	---	---	---	50
BML502	Diagnostic and Therapeutic Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML503	Integrated and Communication Circuit Design	---	----	---	---	25	10	25	10	---	---	---	---	50
BML504	Biomedical Digital Signal Processing	---	---	---	---	25	10	---	---	---	---	25	10	50
BMDLL 501X	Department Level Optional Course Laboratory – I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	150	60	25	10	50	20	25	10	750

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC501	Diagnostic and Therapeutic Instruments (Abbreviated as DTI)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMC501	Diagnostic and Therapeutic Instruments (DTI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC501	Diagnostic and Therapeutic Instruments	04
Course Objective	• To understand the basic principles and working of diagnostic and therapeutic equipment. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcome	Learner will be able to… • Understand principles of various analytical instruments used in hospital laboratories. • Demonstrate the knowledge about various blood cell counting systems and blood gas analyzers. • Demonstarte the knowledge about various automated drug delivery systems. • Understand the basic mechanism of ventilation and analysis of pulmonary functions and demonstarte the use of ventilation therapy. • Unserstand the bsic principle and applications of physiotherapy and eletrotherapy techniques. • Understand the basic principle and working of hemodialysis machine.	

Module	Contents	Hours
1	**Analytical Instruments** 1. Colorimeter 2. Spectrophotometer 3. Auto Analyzer 4. Electrophoresis apparatus 5. Chromatography 6. Chromatography 7. ELISA concepts (direct and indirect), reader & washer.	**12**
2	**Blood cell counter and Blood Gas Analyzer** Blood cell counter (Coulter and Pico-scale) Blood gas analyzer principle, pH. pO2 and pCO2 Electrodes and complete block diagram of Blood gas analyzer.	**6**
3	**Automated drug delivery systems** Infusion pumps, components of drug infusion systems, syringe and peristaltic pumps, Implantable infusion system and insulin pumps.	**4**
4	**Pulmonary Function Analyzer** Respiration measurement technique: Lung volume and capacities, Spirometry, pneumotachometers, Pulmonary function measurement, measurement of volume **Ventilators** Artificial ventilation, ventilator terms and its types, modes of ventilators, classification of ventilators, pressure volume flow and time diagrams. Microprocessor controlled ventilator	**16**
5	**Physiotherapy equipments** **Basic principle, working and technical specifications of** 1. **Shortwave Diathermy** 2. **Ultrasonic therapy unit** 3. **Microwave therapy unit** 4. **Nerve** and Muscle Stimulator.	**6**
6	**Hemodialysis machine** Basic principle of Dialysis and its type. Different types of dialyzer membrane, Portable type. Various monitoring circuits.	**4**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC502	Analog and Digital Circuit Design (Abbreviated as ADCD)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC502	Analog and Digital Circuit Design (ADCD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC502	Analog and Digital Circuit Design	04
Course objective	Students will be able to: • To understand and provide knowledge of various Analog And Digital Circuits Such as Timer IC 555, PLL IC, VCO, 723 voltage regulator . • To understand different types of filters and design them for the given specifications. • To understand, learn and analyze fundamentals of Electronics and Digital circuits. • To develop analytical aptitude and to understand basic electronic concepts related to engineering profession. • To develop competency in terms of logical thinking and application skills. • To design and develop various circuits for biomedical applications and to develop logical thinking of students.	
Course Outcome	Learner will be able to: • Understand various waveform generation IC's and their applications and use it in projects. • Apply the knowledge of various special function IC's and special purpose diodes for designing. • Design active filters and their application in biomedical field and electronic circuit design • Understanding power devices like power diode, SCR, DIAC and TRIAC, UJT and power MOSFET's and their applications in industry • Applying the knowledge of voltage regulators, power supplies, and switches. • Understand different types of ac and dc motors and how to select them for project design.	

Module	Contents	Hours
1.	**Waveform Generation IC's:** • IC 555 Functional Block diagram, Circuit diagram. • IC 555 in Astable Multivibrator(AMV) functional diagram, circuit diagram with application • IC 555 in Monostable Multivibrator (MMV) functional diagram, circuit diagram with application • PLL (IC 565 or equivalent) circuit diagram and applications • VCO(IC 566) Circuit diagram and applications Function Generator (IC 8038 or equivalent) Circuit diagram and its applications	**12**
2.	**Special Function IC's and Special function diodes:** • F-V convertors and V-F convertors: Circuit diagram and its applications • Instrumentation Amplifier (AD 624 /AD 620) Circuit diagram and its applications, • Monolithic Isolation Amplifier module • Opto-couplers and Opto-isolators • Diodes (LED, photodiode,varactor, schottky) PWM (SG 3525 or equivalent) Circuit diagram and its applications	**06**
3.	**Active Filters:** • Frequency response, design of first order (Notch, LP, HP, BP) filter and applications. • Frequency response, design of 2^{nd} order (Chebyshev, Butterworth, Elliptical filters) LP, HP, BP, All pass, Notch, band reject • Capacitor filter, switched capacitor filter. Generalized Impedance Convertor (GIC)	**08**
4.	**Power Devices and Circuits:** • SCR's: Basic structure, characteristics, Two transistor and Operations. series and parallel connections of SCRs. • DIAC and TRIAC: Basic Structure and characteristics, applications • Power diode • UJT: Operation, characteristics, parameters and UJT as a relaxation oscillator Power MOSFET : Device structure, equivalent circuit and characteristics	**06**
5.	**Voltage Controllers and Regulators :** • Analog switches, Relays : Basic Types • Functional block diagram of Voltage Regulators • Types of voltage regulators: Fixed voltage regulators (78XX and 79XX), Adjustable voltage regulator LM317, linear voltage regulator IC 723, Design of low voltage regulator and high voltage regulator using 723. Switching Mode Power Supply (SMPS)	**10**
6.	**Motors And Drivers :** Stepper, Servo, DC/AC Motors drivers and geared motors (Basic operation and application)	**06**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Op-Amps and linear integrated circuits – R. Gayakwad
2. Design with operational amplifiers and analog integrated circuits. Sergio Franco,
3. Integrated Circuits K.R.Botkar.
4. Power Electronics, Ned Mohan.
5. Power Electronics, M.H.Rashid.
6. Power Electronics, M.D.Singh and K.B.Khanchandani,

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Linear Integrated Circuits: Roy Chaudhary
3. Opamps and linear integrated circuits, Theory and Applications- James Fiore.
4. Power Electronics, P.C.Sen.
5. Power Electronics, Dr.P.S.Bimbhra,

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC503	Principles of Communication Engineering (Abbreviated as PCE)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMC503	Principles of Communication Engineering (PCE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC503	Principles of Communication Engineering	04
Course Objective	• To provide concepts, principles and techniques used in analog and digital communications. • To cover a range of digital modulation techniques which are frequently used in modern communication systems.	
Course Outcome	Learner will be able to: • Demonstrate concept of electronic communication system with effect of noise and modeling of noise • Have in depth knowledge of amplitude modulation and be able to compare different types of AM transmitters with analysis • Analyze efficiently different types of AM receivers with characteristics, merits and demerits • Exhibit basic operation of FM transmitter and receiver with types, analysis, advantages and disadvantages • Apply sampling theorem and quantization process in digitizing analog signal with different types of analog and digital pulse modulation • Understand and compare different types of digital transmission techniques and multiplexing techniques	

Module	Contents	Time
1	**Introduction to communication system and noise:** • Elements of communication system, types of communication system • Noise definition, types, Signal to Noise ratio, Noise factor, Noise figure, Noise Temperature	04
2	**Amplitude Modulation Transmission:** • Definition, Mathematical analysis of AM wave, Different types of AM, Spectrum, Bandwidth, • AM transmitter: High and low level AM transmitter • Generation: DSBFC AM (Grid, plate and collector modulated AM generator, DSBSC AM (Ring and FET balanced modulator) and SSB AM (Filter, phase shift and Third method) • Introduction to ISB and VSB transmitter	10
3	**Amplitude Modulation Receiver:** • Receiver characteristics: sensitivity, selectivity, fidelity, double spotting, Image frequency and its rejection, dynamic range • Types: TRF receiver, superetrodyne receiver, double conversion receiver • AM detectors –Simple and Practical Diode detector, Principles and types of tracking and AGC, SSB detector	08
4	**Frequency Modulation Transmission and Receivers :** • Principles of FM waveform, spectrum, Bandwidth • FM generation: Direct and Indirect FM transmitter • Principles of AFC, Effect of noise in FM, Noise Triangle, Pre-emphasis and De-emphasis • FM Receivers: Block diagram • Types: Simple Slope detector, Balanced slope detector, Foster Seeley discriminator, Ratio detector, Quadrature detector • Capture effect in FM receivers, Difference between AM and FM system	10
5	**Analog and Digital Pulse Modulation Techniques :** • Sampling Theorem for low pass signals and band pass signals, Proof of Sampling theorem, Concept of Aliasing, Quantization, Companding, • Analog modulation techniques: PAM, PWM,PPM – Generation, Detection, Advantages, disadvantages • Digital pulse modulation techniques: PCM, DPCM, DM and ADM– Generation, Detection, Advantages, disadvantages	08
6	**Digital Transmission Techniques and Multiplexing :** • Digital transmission types: ASK, FSK, PSK - Generation, Detection, Advantages Disadvantages • Multiplexing techniques: Concept of multiplexing, FDM, TDM, Hierarchy, Applications, Advantages Disadvantages	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Electronic communication system – Wayne Tomasi,Pearson Education
2. Electronic communication system – Roy Blake, Thomson Learning
3. Electronic communication system - Kennedy and Devis,TMH

Reference Books:

1. Digital and Analog communication system – Leon W Couch, Pearson Education
2. Principles of communication system – Taub and Schilling ,TMH

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC504	Biomedical Digital Signal Processing (Abbreviated as BDSP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMC504	Biomedical Digital Signal Processing (BDSP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC504	Biomedical Digital Signal Processing	04
Course Objective	• To build a strong base for developing algorithms for signal processing systems and Imaging systems. • To develop competency in terms of logical thinking, programming and application skills. • To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcome	Learner will be able to, • Understand the fundamental techniques and applications of digital signal • Processing with emphasis on biomedical signals. • 2. Implement algorithms based on discrete time signals. • 3. Understand Circular and linear convolution and their implementation using DFT • 4. Understand efficient computation techniques such as DIT and DIF FFT algorithms • 5. Design FIR filters using window method, digital IIR filters by designing prototype analog filters and then applying analog to digital conversion.	

Module	Contents	Hours
1.	Basic Elements of DSP, Discrete time signals and systems, DTFT, Z Transform(ZT) – Properties of ZT , Inverse ZT, solution of LCCDE with initial conditions – zero input response and zero state response -basic concept of BIBO stability, Application of ZT and IZT	**08**
2.	Introduction to DFT-Properties of DFT	**08**
3.	Introduction DIT and DIF FFT algorithms. Use of FFT in linear filtering,	**07**
4.	Review of Design of analog Butterworth and Chebyshev Filters, Frequency transformation in analog domain, Design of IIR Digital Filters using Impulse invariance method-Design of digital Filters using Bilinear transformation	**11**
5.	Structure of FIR filters-Linear phase filters –Filter design using window technique-Frequency sampling techniques . Realisation of FIR &IIR filters Direct ,cascade and parallel forms	**10**
6.	Introduction to Digital signal Processors–Architecture –Features-addressing formats –functional mode-introduction to commercial Processors. Application of DSP in Biomedical Applications	**04**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Digital signal processing Principles Algorithms and Application –Proakis &Manolakis –Third edition PHI
2. Digital Signal Processing –Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C.Gnanapriya, 2/ed Tata McGraw Hill

Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W.Schafer- PHI
2. Understanding Digital Signal Processing –Richard G. Lyons-3/ed Pearson Publication

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 5011	Department Level Optional Course – I Healthcare Database Management (Abbreviated as HCDM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 5011	Department Level Optional Course – I Healthcare Database Management (HCDM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO5011	Healthcare Database Management	04
Course Objective	• Learn and practice data modelling using the entity-relationship and developing database designs. • Understand the use of Structured Query Language (SQL) and learn SQL syntax. • To create, display, validate and search XML files • To create windows applications using standard .NET controls. • To acquire knowledge of client side scripting language thereby to reduce the load on server and minimize the response time. • To create, validate and display web data.	
Course Outcome	Learner will be able to, • Design data models and schemas in DBMS and apply the features of database management systems and Relational database. • Construct tables and retrieve data from the database by using SQL- the standard language of relational databases. • Implement client side scripting and validation. • Create XML documents using XML schema and XSL elements.	

	• Using operators, variables, and control structures in JavaScript • Designing of windows applications using VB.NET

Module	Contents	Hours
1	**Introduction Database Concepts and Entity Relationship Data Model:** Introduction, Characteristics of databases, File system V/s Database system, DBMS system architecture, Database Administrator, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalization, specialization	**05**
2	**Structured Query Language (SQL) :** Overview of SQL , Data Definition Commands, Set operations , aggregate function , null values, , Data Manipulation commands, Data Control commands , Views in SQL, Nested and complex queries	**10**
3	**Transactions Management and Concurrency:** Transaction concept, Transaction states, ACID properties	**06**
4	**JavaScript** Introduction, Variables and its Scope, Comments, Operators (Arithmetic and Assignment), Data Types, JavaScript language constructs (if, if-else, while, do-while, for, switch), Functions, Objects (Properties, Methods and Events), Built-in Objects (Array, Number, Date, Math, String, RegEx), Browser Objects (Window, Document, Location, History, Cookies) DOM (Document Object Model), Manipulation, Form Validation	**08**
5	**Web Extensions:** XML Documents, XML Elements, Attributes XML Schema, Namespaces , Style Sheets, XPath, Introduction to X-Query	**08**
6	**Programming with VB.Net :** Variables, Comments, Constants, Keywords, DataTypes, Conditional Statements, Select Case Statement, Loops (For Loop, while Loop, do Loop, For Each Loop), Arrays, Option Explicit, Option Strict, Standard Controls - Windows Application	**11**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. G. K. Gupta :"Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, " Fundamentals of Database Systems", 5thEdition, PEARSON Education.
4. Peter Rob and Carlos Coronel, " Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition
5. Crockford, Douglas, "JavaScript: The Good Parts", Shroff
6. Heather Williamson, "XML: The Complete Reference", McGraw Hill Education

7. Imar Spaanjaars, “Beginning ASP.NET 4.5.1 in C# and VB”, Wiley

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
2. Mark L. Gillenson, Paulraj Ponniah, “ Introduction to Database Management”,Wiley
3. Sharaman Shah ,”Oracle for Professional”, SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, “ Database Management Systems”,TMH
5. Debabrata Sahoo “Database Management Systems” Tata McGraw Hill, Schaum’s Outline

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 5012	Department Level Optional Course – I Biostatistics (Abbreviated as BIOSTATS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMDLO 5012	Department Level Optional Course – I Biostatistics (BIOSTATS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO5012	BIOSTATISTICS	04
Course Objective	• To cover basic concepts and theory related to statistics. • To focus on various statistical abilities such as analysis of variance, hypothesis testing, estimation, etc.	
Course Outcome	A learner will be able to • Apply statistical methods to sample data and analyse it. • Develop a strong foundation for designing algorithms for computation.	

Module	Contents	Hours
1.	Descriptive statistics and probability Frequency distribution, Measures of central tendency, Measures of dispersion Basic probability and Bayes theorem.	04
2.	Probability and Sampling Distributions Discrete probability distributions Continuous probability distributions - Binomial, poisson and normal distributions Sampling distributions – sample mean, difference between two sample means, sample proportions, difference between two sample proportions	10
3.	Estimation t- distribution Confidence intervals for - population mean, difference between two population means, population proportion, difference between two population proportions, variance of normally	07

	distributed population, ratio of variances of two normally distributed populations Determination of sample size for estimating mean and proportions	
4.	Hypothesis testing Hypothesis testing for – Population mean, difference between two population means, population proportions, difference between two population proportions, population variance, ratio of two population variances Type – I and II error and power of test	**07**
5.	Analysis of variance Completely randomized design, Randomized complete block design, repeated measures design, factorial experiment. Regression and Correlation Simple linear regression, correlation model, correlation coefficient, multiple regression, multiple correlation	**13**
6.	Chi square distribution and analysis of frequency Chi-square distribution – properties Test of goodness of fit, independence and homogeneity	**07**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Biostatistics – A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of mathematical statistics by S. C. Gupta and V. K. Kapoor, second edition, Sultan Chand Publisher
3. Probability and statistics for engineers by J. Ravichandran, Wiley /india

Reference Books:

1. Biostatistics – How it works by Steve selvin, Pearson education
2. An Introduction to Biostatistics by Sunder Rao and J. Richard, Third Edition, Prentice Hall of India
3. Probability and Statistics by Schaum's series

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 5013	Department Level Optional Course – I Rehabilitation Engineering (Abbreviated as RE)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMDLO 5013	Department Level Optional Course – I Rehabilitation Engineering (RE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Code	Credits
BMDLO5013	Rehabilitation Engineering	04
Course Objectives	To introduce learners to basics of Kinetics and Kinematics, Flow properties of blood and give overview of Rehabilitation Engineering.	
Course Outcomes	A learner will be able to Build foundation for learners enabling the learners to pursue higher studies with specialization in Rehabilitation Engineering.	

Module	Contents	Hours
1.	**Introduction and socio-legal aspects of Rehabilitation Engineering:** Medical Rehabilitation, Epidemiology of Rehabilitation, preventive Rehabilitation, Impairment Disability and Handicap. Delivery of Rehabilitation Care: The team-Medical, Paramedical , Socio-vocational	06
2.	**Orthotics, Amputation, and Prosthetics, Activities of Daily Living (ADL):** Orthotics: General Principles of Orthotics, Biomechanics of orthotics, Classification: Upper & Lower Extremity orthotics, spinal Orthotics Amputation & Prosthetics: Causes of Amputation, Types of Amputation, and Levels of Amputation for upper and lower Extremity. Preoperative and post-operative period. Pre-prosthetic stage. Endo & Exo-skeletal Prosthetics. Classification: Upper & lower limb Prosthetics Activities of Daily Living: ADL grouping, Barthel's Index of ADL. Functional	13

	Independence, Measures, Environmental control system, communication, ADL training.	
3.	**Mechanical principles of Kinematics and Kinetics:** Planar classification of position and motion, Rotary and translatory motion, Degree of freedom, Kinematic Chain Theories of motion, Levers, Torque, Parallel force, Resolution of force, Calculation of muscle and joint forces Clinical application on weight and center of gravity ,applied weights and resistance, muscle force and leverage, joint forces, Clinical application on stretching versus joint mobilization	**08**
4.	**Flow properties of blood:** An outline of Blood Rheology, Constitutive equation of blood based viscometric Data and Casson's equation, laminar flow of blood in a tube, fluid mechanical interaction of RBCs with a solid wall, thrombus formation and dissolution, medical application of Blood Rheology	**08**
5.	**Common deformities and role of surgery in rehabilitation engineering.** Types of deformities, Management of 1st and 2nd degree deformities. Common deformities of lower limb. Treatment for partial foot deformities. Deformities of the foot. Arm deformities. Torticollis	**05**
6.	**An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:** Muscular Dystrophy, Duchenne Muscular Dystrophy, Rehabilitation, facioscapulohumeral Muscular Dystrophy Paraplegia: Etiology, mechanism of injury, Identification of level of lesion, Management of active spinal cord injury, Rehabilitation, Gait training Quadriplegia: Mobility, Training, Level of injury & outcome, Management	**08**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, Elizabeth Laurance Weiss; Jaypee brothers Publication
2. Mechanical properties of living tissues by Y. C. Fung

Reference Books:

1. Textbook of Rehabilitation by S. Sundar,3rd edition Jaypee publication

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML501	Business Communication and Ethics (Abbreviated as BCE)	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML501	Business Communication and Ethics (BCE)	--	--	--	--	50	--	--	--	50

Course Code	Course Name	Credits
BMC501	Business Communication and Ethics	02
Course Objective	1. To inculcate professional and ethical attitude at the workplace. 2. To enhance effective communication and interpersonal skills. 3. To build multidisciplinary approach towards all life tasks. 4. To hone analytical and logical skills for problem-solving.	
Course Outcome	A learner will be able to 1. Design a technical document using precise language, suitable vocabulary and apt style. 2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships. 3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities. 4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP. 5. Deliver formal presentations effectively implementing the verbal and non-verbal skills.	

Module	Detailed Contents	Hrs.
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**

2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	**Employment Skills**	**07**
6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work:

Term work shall consist of all assignments from the list. The distribution of marks for term work shall be as follows:

Book Report……..(10) Marks

Assignments …… (10) Marks
Project Report Presentation…….. (15) Marks
Group Discussion.…… (10) Marks
Attendance ……(05) Marks
TOTAL: ……(50) Marks

The final certification and acceptance of term work ensures the satisfactory performance of work assigned and minimum passing in the term work.

References

1. Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition
5. Heta Murphy, *"Effective Business Communication",* Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML502	Diagnostic and Therapeutic Instruments (DTI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML502	Diagnostic and Therapeutic Instruments (DTI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML502	Diagnostic & Therapeutic Instrumentation	01
Course Objective	• To demonstrate the application technique of diagnostic and therapeutic equipment. • To implement the basic circuits used in diagnostic and therapeutic equipment.	
Course Outcome	**Learner will be able to…** • Appreciate the importance of wavelength selection for measurement of various ions present in the sample. • Understand principles of various analytical instruments used in hospital laboratories. • Design and Implement power supply of egulated v • Understand the basic principle and applications of physiotherapy and electrotherapy techniques. • Compare the applications of various types of physiotherapy equipments. • Understand the basic principle and working of hemodialysis machine.	

Syllabus: Same as that of BMC501 Diagnostic and Therapeutic Instruments.

List of Experiments: (Any Seven)

1. Selection of wavelength for Colorimeter and spectrophotometer
2. Find out the concentration of unknown sample using colorimeter and spectrophotometer.
3. Design and Implementation of 6V , 1 Amp regulated power supply
4. Design and Implementation of temperature controller circuit for hemodialysis machine.
5. Demonstration of shortwave diathermy.
6. Demonstration of ultrasonic diathermy.
7. Demonstration of nerve and muscle stimulator.
8. Industry / Hospital visit to be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 05 Marks
Presentation : 05 Marks
Attendance : 05 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML503	Integrated and Communication Circuit Design (ICCD)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML503	Integrated and Communication Circuit Design (ICCD)	--	--	--	--	25	25	--	--	50

Course Code	Course Name	Credits
BMC503	Integrated and Communication Circuit Design	01
Course Objective	• To understand, analyze and design integrated circuits. • To analyze various analog modulation techniques.	
Course Outcome	Learner will be able to, • Apply the knowledge of various special function IC's, filters, power devices, voltage regulators and motors for designing. • Implement and design various analog modulator and demodulator circuits.	

Syllabus: Same as that of BMC502 Analog and Digital Circuit Design (ADCD)and BMC503 Principles of Communication Engineering (PCE).

Suggested Experiments for Integrated Circuit Design (ICD): (Any four)

1. Design AMV and MMV and their applications.
2. To design a voltage regulator.
3. Function Generator IC 8038
4. VCO and PLL ICs and their applications.
5. Design for Band pass /Band reject
6. Design of Notch filer / Twin T filter
7. Design of Low Pass Filter/ High pas Filter
8. Experiments on SCR/DIAC/TRIAC/UJT relaxation oscillator.

Suggested Experiments for Communication Circuit Design (CCD): (Any four)

1. DSB-SC, DSB-FC, SSB AM generation and detection
2. FM generation and detection
3. Pre-emphasis and De-emphasis
4. Sampling and reconstruction
5. PAM generation and detection
6. PWM generation and detection
7. PPM generation and detection
8. Time/Frequency division multiplexing

Assessment:

Term Work:

Term work consists of minimum eight experiments based on the syllabus (four experiments on "Integrated Circuit Design" and four experiments on "Communication Circuit Design").
The distribution of the term work shall be as follows:
Laboratory work (Experiments and Journal on ICD) : 10 marks
Laboratory work (Experiments and Journal on CCD) : 10 marks
Attendance : 05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Books Recommended:

Text books:

1. Op-Amps and linear integrated circuits – R. Gayakwad
2. Linear Integrated Circuits: Roy Chaudhary
3. Design with operational amplifiers and analog integrated circuits. Sergio Franco,
4. Integrated Circuits K.R.Botkar.
5. Power Electronics, Ned Mohan.
6. Power Electronics, M.H.Rashid.
7. Power Electronics, M.D.Singh and K.B.Khanchandani,
8. Electronic communication system – Wayne Tomasi,Pearson Education
9. Electronic communication system – Roy Blake, Thomson Learning
10. Electronic communication system - Kennedy and Devis,TMH

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore.
3. Power Electronics, P.C.Sen.
4. Power Electronics, Dr.P.S.Bimbhra,
5. Digital and Analog communication system – Leon W Couch, Pearson Education
6. Principles of communication system – Taub and Schilling ,TMH

Practical examination will be based on suggested practical list.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML504	Biomedical Digital Signal Processing (BDSP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML504	Biomedical Digital Signal Processing (BDSP)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML504	Biomedical Digital Signal Processing	01
Course Objective	• To build a strong base for developing algorithms for signal processing systems and Imaging systems. • To develop competency in terms of logical thinking, programming and application skills. • To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcome	Learner will be able to, • Understand the fundamental techniques and applications of digital signal processing with emphasis on biomedical signals. • Implement algorithms based on discrete time signals. • Understand Circular and linear convolution and their implementation using DFT • Understand efficient computation techniques such as DIT and DIF FFT algorithms • Design FIR filters using window method, digital IIR filters by designing prototype analog filters and then applying analog to digital conversion.	

Syllabus: Same as that of BMC504 Biomedical Digital Signal Processing (BDSP)

Suggested Experiments: (Any Seven)

1. Basics of Programming
2. Simulations of standard signals
3. Operations on Signals
4. Concept of Aliasing
5. Linear convolution circular convolution
6. Sampling Theorem
7. Z-Transform
8. Discrete Fourier Transform(DFT)
9. Fast Fourier Transform (FFT)
10. Design and simulation of FIR filter
11. IIR filters using Butterworth approximation
12. IIR filter using Chebyshev approximation

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Text books:

1. Digital signal processing Principles Algorithms and Application –Proakis &Manolakis –Third edition PHI
2. Digital Signal Processing –Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C.Gnanapriya, 2/ed Tata McGraw Hill

Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W.Schafer- PHI
2. Understanding Digital Signal Processing –Richard G. Lyons-3/ed Pearson Publication

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 5011	Department Level Optional Course – I Healthcare Database Management (Abbreviated HCDM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 5011	Department Level Optional Course – I Healthcare Database Management (HCDM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL5011	Healthcare Database Management	01
Course Objective	• Learn and practice data modelling using the entity-relationship and developing database designs. • Understand the use of Structured Query Language (SQL) and learn SQL syntax. • To create, display, validate and search XML files • To create windows applications using standard .NET controls. • To acquire knowledge of client side scripting language thereby to reduce the load on server and minimize the response time. • To create, validate and display web data.	
Course Outcome	Learner will be able to, • Design data models and schemas in DBMS and apply the features of database management systems and Relational database. • Construct tables and retrieve data from the database by using SQL- the standard language of relational databases. • Implement client side scripting and validation. • Create XML documents using XML schema and XSL elements. • Using operators, variables, and control structures in JavaScript • Designing of windows applications using VB.NET	

Syllabus: Same as that of BMDLO5011 Healthcare Database Management

List of Experiments:

1. To draw an ER diagram for a selected case study
2. Study of Basic SQL commands
3. Accessing & Modifying Data in Oracle
4. To study and implement Joins and Views
5. To study and implement Subqueries
6. Develop a simple calculator application in VB.Net using standard controls
7. Develop a console based application to demonstrate use of either conditional statements or loops
8. Create XML document, Schema and Validate it
9. X-Path

Any other experiment/tutorial/Assignment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. G. K. Gupta :"Database Management Systems", McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
3. Elmasri and Navathe, " Fundamentals of Database Systems", 5thEdition, PEARSON Education.
4. Peter Rob and Carlos Coronel, " Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition
5. Crockford, Douglas, "JavaScript: The Good Parts", Shroff
6. Heather Williamson, "XML: The Complete Reference", McGraw Hill Education
7. Imar Spaanjaars, "Beginning ASP.NET 4.5.1 in C# and VB", Wiley

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
2. Mark L. Gillenson, Paulraj Ponniah, " Introduction to Database Management",Wiley
3. Sharaman Shah ,"Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems",TMH
5. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 5012	Department Level Optional Course – I Biostatistics (BIOSTATS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 5012	Department Level Optional Course – I Biostatistics (BIOSTATS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL5012	Biostatistics	01
Course Objective	• To conduct statistical analysis using Statistical tools.	
Course Outcome	Learner will be able to • Apply statistical methods to sample data and analyse it using statistical tools.	

Syllabus: Same as that of BMDLO 5012 Biostatistics (BIOSTATS)

Laboratory experiments may be conducted using SCILAB or any other statistical Software

List of Laboratory Experiments: (Any Seven)

1. Descriptive statistics and probability
2. Discrete probability distributions
3. Continuous probability distributions
4. Sampling distributions
5. Estimation
6. Hypothesis testing
7. Analysis of variance
8. Regression and Correlation
9. Chi square distribution and analysis of frequency

Any other experiment based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Biostatistics – A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of mathematical statistics by S. C. Gupta and V. K. Kapoor, second edition, Sultan Chand Publisher
3. Probability and statistics for engineers by J. Ravichandran, Wiley /india

Reference Books:

1. Biostatistics – How it works by Steve selvin, Pearson education
2. An Introduction to Biostatistics by Sunder Rao and J. Richard, Third Edition, Prentice Hall of India
3. Probability and Statistics by Schaum's series

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 5013	Department Level Optional Course – I Rehabilitation Engineering (RE)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 5013	Department Level Optional Course – I Rehabilitation Engineering (RE)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL5013	Rehabilitation Engineering	01
Course Objective	To introduce learners to basics of Kinetics and Kinematics, Flow properties of blood and give overview of Rehabilitation Engineering.	
Course Outcome	A learner will be able to Build foundation for learners enabling the learners to pursue higher studies with specialization in Rehabilitation Engineering.	

Syllabus: Same as that of BMDLO5013 Rehabilitation Engineering (RE)

Laboratory work:

1. Demonstrations in hospital / Industry.
2. Discussion on research articles and recent developments in the field of medicine.
3. Group presentations on the latest technology in hospitals based on the topics covered in the syllabus.
4. 5 Assignments based on the entire syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work : 10 Marks
Laboratory work (Documentation) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference books:

1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet resources.

Oral examination will be based on suggested practical list and entire syllabus.

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC601	Biomedical Monitoring Equipment	04	----	----	04	----	----	04
BMC602	Microprocessors and Microcontrollers	04	----	----	04	----	----	04
BMC603	Digital Image Processing	04	----	----	04	----	----	04
BMC604	Medical Imaging-I	04	----	----	04	----	----	04
BMDLO602X	Department Level Optional Course – II	04	----	----	04	----	----	04
BML601	Biomedical Monitoring Equipment	----	02	----	----	01	----	01
BML602	Microprocessors and Microcontrollers	----	02	----	----	01	----	01
BML603	Digital Image Processing	----	02	----	----	01	----	01
BML604	Medical Imaging-I	----	02	----	----	01	----	01
BMDLL602X	Department Level Optional Course Laboratory – II	----	02	----	----	01	----	01
Total		20	10	----	20	05	----	25

Examination Scheme for Semester VI

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC601	Biomedical Monitoring Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC602	Microprocessors and Microcontrollers	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC603	Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC604	Medical Imaging-I	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 602X	Department Level Optional Course – II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML601	Biomedical Monitoring Equipment	---	---	---	---	25	10	---	---	---	---	25	10	50
BML602	Microprocessors and Microcontrollers	---	---	---	---	25	10	---	---	---	---	25	10	50
BML603	Digital Image Processing	---	----	---	---	25	10	---	---	---	---	25	10	50
BML604	Medical Imaging-I	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 602X	Department Level Optional Course Laboratory – II	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	125	50	---	---	50	20	75	30	750

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC601	Biomedical Monitoring Equipment (Abbreviated as BME)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC601	Biomedical Monitoring Equipment (BME)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC601	Biomedical Monitoring Equipment	04
Course Objective	• To understand the basic principles and working of patient monitoring system. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcome	Learner will be able to: • Provide a better understanding about various bioelectrical signal recorders and patient safety • Demonstrate the principles of electronics used in designing various biomedical monitoring equipment. • Understand the basic princples and working of audiometry equipments and hearing aids • Provide a better understanding about foetal and neonatal monitoring systems. • Acquire the ability to explain the various blood flow and cardiac output meauremnet devices. • Acquire in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care Equipment and the advanced technologies such as Telemetry and Telemedicine.	

Module	Contents	Hours
1	**Bioelectrical signals and recorders** ECG, EMG and EEG signals, LEAD configurations, 10-20 electrode system Measuring techniques for EOG, ERG and Phonocardiography, **Patient Safety:** Electric Shock Hazards, Leakage currents, safety codes for electro-medical equipment.	**10**
2	**Arrhythmia and Patient monitoring:** Cardiac Arrhythmias, waveforms and interpretation from them. Stress test measurement. Ambulatory monitoring instruments-Holter monitor. Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnoea Detector. Electrical Safety in Biophysical Measurements. Heart rate variability measurement and applications. **Point of care devices and their design considerations for homecare devices:** glucometer, lung function test.	**16**
3	**Audiometers and hearing aid** Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry, Conventional and Digital Hearing Aids, Cochlear Implants.	**04**
4	**Foetal and Neonatal Monitoring System:** Cardiotocograph, Methods of monitoring of Foetal Heart rate, Monitoring of labour activity, Incubator and Infant warmer, Non-stress test monitoring.	**05**
5	**Blood flow and Cardiac output** Electromagnetic, Ultrasonic, NMR and Laser Doppler flowmetry, Indicator Dilution, Dye Dilution and Thermal Dilution Techniques.	**05**
6	**Bio-Telemetry and Telemedicine** General Telemetry System, Single channel and Multi-channel, Landline and Radio-frequency Telemetry, Telemedicine, its essential parameters and delivery modes and its Applications.	**08**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet websites.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC602	Microprocessors and Microcontrollers (Abbreviated as MPMC)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMC602	Micro-processors and Micro-controllers (MPMC)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC602	Microprocessors and Microcontrollers	04
Course Objective	• To create a strong foundation by studying the basics of Microprocessors and Microcontroller interfacing to various peripherals which will lead to a well-designed Microprocessor/ Microcontroller System.	
Course Outcome	Learner will be able to: • Understand the basic of Microprocessor and Microcontroller based systems and their architecture. • Understand 8086 microprocessor along with its architecture and memory organization. • Understand peripheral controller ICs used in interfacing. • Understand 8051 Microcontroller architecture, memory organization, Interrupt structure, Port structure, Timers/Counters • Understand assembly language and C compilers used to program 8051 • Design simple interfaces for keyboard LCD, ADC/DAC and Stepper motors	

Module	Contents	Hours
1.	**Introduction to Microprocessor** Introduction to Microprocessor and Microcontroller, Microcomputer based system elements, Generalized block diagram of Microprocessor, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture, Microprocessor Programming languages, Microcomputer System software, Evolution of Microprocessor ,machine cycle, T states and concepts of read write cycles.	**04**
2.	**Architecture of Intel 8086 Microprocessor** Major features of 8086 processor, 8086/88, CPU Architecture and the pipelined operation, Programmer's Model and Memory Segmentation	**04**
3.	**Peripheral Controllers for 8086 family and System Design:** Functional Block Diagram and description, Control Word Formats, Operating Modes and Applications of the Peripheral Controller namely 8255-PPI, , 8259- PIC and 8237-DMAC, 8279- Display and Keyboard driver, Interfacing of the above Peripheral Controllers. Keyboard and Display Interface.	**08**
4.	**MCS-51 Microcontroller** 8051 architecture ; its variants and comparision, comparision of microprocessor and microcontrollers, CPU timing and machine cycle, memory organisation, SFR's, integrated prepherials such as timers/counters, serial ports, parallel I/O ports, interrupt structure, memory interfacing power saving and power down modes.	**10**
5.	**8051programming** Assembly language programming process, programming tools, addressing modes, instruction set and Programming practice using assembly and C compilers	**12**
6.	**Microcontroller design and interfacing case studies** Interfacing with external memories, Interfacing with 8255, Interfacing with 7 segment display, Interfacing with keyboard, interfacing with LCD, Interfacing with ADC, DAC and Sensors, Interfacing with stepper motor Interfacing with PC using RS232	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
2. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
3. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
4. The 8051 microcontrollers-Kenneth J Ayala

5. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
6. Using MCS-51 Microcontroller Han-Way Huang,.
7. 8051 microcontroller hardware, software applications.V Udayashankara, M S Mallikarjunaswamy

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
4. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication
5. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
6. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
7. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
8. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC603	Digital Image Processing (Abbreviated as DIP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC603	Digital Image Processing (DIP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC603	Digital Image Processing	04
Course Objective	• To introduce the learners the basic theory of digital image processing. • To expose learners to various available techniques and possibilities of this field. • To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. • To prepare learners to formulate solutions to general image processing problems. • To develop hands-on experience in using computers to process images. • To familiarize with MATLAB / C/ Labview / similar software for processing digital images.	
Course Outcome	Learner will be able to: • Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. • Analyze images in the spatial domain. • Analyze images in the frequency domain through the Fourier transform. • Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing**.**	

Module	Detailed Contents	Hours
1.	**Basics of Image Processing**: Image acquisition, Processing, Communication, Display; Electromagnetic spectrum; Elements of visual perception - Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, Image formation model, Uniform and non-uniform sampling, Quantization, Image formats.	**05**
2.	**Image Enhancement**: Spatial domain - Point processing techniques, Histogram processing, Neighbourhood processing, Frequency domain techniques - 2D-DFT, Properties of 2D-DFT, Low pass, High pass, Noise removal, Homomorphic filters,	**12**
3.	**Image Segmentation**: Basic relationships between pixels - Neighbours, Adjacency, Connectivity, Regions, Boundaries, Distance measures; Detection of discontinuities, Point, Line, Edge detection, Edge linking, Hough transform, Thresholding-based segmentation, Region-based segmentation.	**08**
4.	**Image Transforms**: DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Slant, K-L Transforms, Basis functions and basis images	**08**
5.	**Image Compression**: Fundamentals of image compression models, Lossless compression - RLE, Huffman, LZW, Arithmetic coding techniques. Lossy compression - IGS coding, Predictive coding, Transform coding, JPEG, JPEG 2000.	**08**
6.	**Morphology, Representation and Description**: Dilation, Erosion, Open, Close, Hit-or-miss, Boundary extraction, Region filling, Thinning and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	**07**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text Books:
1. Digital Image Processing, Gonzalez and Woods- Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder-Prentice Hall India.

Reference Books:
1. Digital Image Processing and Computer Vision, Sonka, Hlavac, Boyle-Cengage learning.
2. Digital Image Processing, William Pratt- John Wiley.

Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC604	Medical Imaging - I (Abbreviated as MI - I)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC604	Medical Imaging - I (MI - I)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC604	Medical Imaging - I	04
Course Objective	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging	
Course Outcome	Learner will be able to: • Understand X ray imaging along with X ray tube construction, X ray generators and the total radiographic system. • Understand Fluoroscopic Imaging and Digital Subtraction Angiography. • Distinguish between CR and DR. Understand Mammography. • Understand the technique of Computed tomography, the CT scanner configuration, reconstruction techniques and clinical applications. • Apply the knowledge of CT and learn advancements in CT. • Understand the applications of X-rays in the field of Radiotherapy.	

Module	Detailed Contents	Hours
1.	**X- ray Imaging**: Properties of X rays, production of X rays, X ray interaction with matter, Attenuation Total radiographic System: X –ray tubes, Rating of X ray tubes, X –ray generators, Filters, Grids, Beam Restrictors, Control Panel, X ray Film	14
2.	**Fluoroscopic Imaging** and X ray Image Intensifier, Digital subtraction Angiography	05
3.	**Computed Radiography and Digital Radiography** **Mammography**	04

4.	**Principle of Computed tomography** Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, CT Number ,Data Acquisition System, Spiral CT: technology and applications, Reconstruction Techniques:- Radon Transform, Iterative, Filtered back projection, Fourier reconstruction, CT artefacts, Clinical applications of CT	**14**
5.	**Advancements in CT** Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography, Contrast agents in CT	**05**
6.	**Linear Accelerators:** Production and transport of the RF wave, Major components of linear accelerator, Clinical Applications.	**06**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. Practical Radiotherapy: Physics and equipment: Pam Cherry, Angela Duxbury

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6021	Department Level Optional Course- II Healthcare Software (Abbreviated as HCS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 6021	Department Level Optional Course - II Healthcare Software (HCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6021	Healthcare Software	04
Course Objective	• To setup programming environment for ASP.NET programs • To develop modular applications using object oriented methodologies • To configure ASP.NET application and creating applications using standard .NET controls • To develop data driven web application • To connect different data sources and manage them • To maintain session and controls related information in multi-user web applications	
Course Outcome	Learner will be able to: • Understanding of Microsoft .NET Framework and ASP.NET page structure • Designing of windows applications using C#.NET • Designing of web applications using ASP.NET controls • Creating database driven ASP.NET web applications using SQL Server • Debugging and deploying ASP.NET web applications.	

Module	Contents	Hours
1	**Introduction to .NET Programming:** • .Net Concepts: Framework, Common Language Runtime, Base Class Library, Common Type System (CTS), Assemblies, Namespaces. • Programming with C#: Variables, Comments, Constants, Keywords, Data Types, Control Statements, Conditional Statements, Switch Statement, Loops, Jump, Statements, Goto, break, Continue, Return, Arrays. • Exception handling in C# • Object Oriented Programming (OOP): Class, Object, Encapsulation, Inheritance, Polymorphism, Constructors.	12
2	**Developing Windows Forms Applications:** • Standard Controls - Windows Application: Labels, Textboxes, Rich Text Box, Button, Check Box, Radio Button, Combo Box, Picture Box, List Box, Image List, List View, Tab Control, Menu Strip, Data Grid View, Date Picker • Event Handlers: Creating Event Handlers, Default Event Handlers, Associating Event Handlers at Run Time.	06
3	**Developing Web Applications using ASP.NET and C#** • Introduction to ASP.Net: From ASP to ASP.NET, ASP.NET Features, Web Forms Life Cycle, Request/Response Programming. • Web Applications Using Visual Studio: Using Visual Web Developer, Using Components, Using the Global.asax file. • State Management: Session State, Application State, Cookies. • Server Control: HTML Server Controls, Web Forms Server Controls, Rich Controls, Validation Controls. • Themes • Configuration: Using the machine. config file, Using the web. config file, Globalization and Localization.	12
4	• **Data access and manipulation with ADO.NET using SQL Server** Introduction to ADO.NET, Data Providers in .NET, Connected and Disconnected architecture, ADO.NET Architecture, Command Object, Data Adapter and Data Set, Data Tables and Data Views, Updating the Dataset.	10
5	**Security, Deployment, & Introduction to advanced concepts** • Security: Authentication, Authorization, Impersonation, Code Access Security • Deployment.	04
6	**Introduction to advanced concepts of .Net framework:** Windows Presentation Foundation (WPF), Windows Communication Foundation (WCF), Windows Workflow Foundation (WWF), Windows Card Space (WCS).	04

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text Books:
1. ASP.NET 3.5 Unleashed (Sams) - Stephen Walther
2. Microsoft ASP.NET Step by Step (Microsoft Press) - G. Andrew Duthrie

Reference Books:
1. Designing Microsoft ASP.NET Applications (Microsoft Press) - Jonathon Goodyear, Brian Peek, Brad Fox
2. Deploying and Managing Microsoft .NET Web Farms (Sams) - Barry Bloom

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6022	Department Level Optional Course- II Lasers and Fibre Optics (Abbreviated as LFO)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMDLO 6022	Department Level Optional Course - II Lasers and Fibre Optics (LFO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6012	Lasers and Fiber Optics	04
Course Objective	• To understand the fundamentals in Laser and Fiber Optics. • To understand the applications of Laser and Fiber optics in health sector.	
Course Outcome	Learner will be able to: • Understand the fundamentals and clinical applications of Laser and Fiber Optics. • Correlate the knowledge of medicine and engineering for the wellness of human being. • Understand the safety aspects while dealing with Laser and Fiber Optic Units.	

Module	Contents	Hours
1.	**Laser Fundamentals** Fundamental wave properties and quantum properties of light, Energy levels and Radiative properties, Absorption and Stimulated Emission, Laser Amplifiers, Laser Oscillation above threshold, Requirements for obtaining Population Inversion, Laser pumping requirements and techniques, Laser Resonators, Cavity modes, Laser interaction with tissue- Effects and principles, Thermal interaction between laser and tissue.	10

2.	**Laser Types, construction and working** Laser system involving low density gain medium: He-Ne laser, Argon Ion Laser, He-Cadmium laser, Carbon dioxide Laser, Excimer laser, Nitrogen Laser Laser system involving high density gain medium: Solid State laser like Ruby laser, Nd-YAG Laser, Titanium Sapphire Laser, Fiber Lasers, Semiconductor Diode Laser	**10**
3.	**Laser safety:** Practical Laser Safety requirements, Environmental safety, Equipment safety, personnel protection, Education/training for handling laser equipment, Role of Laser Safety officer, Standards of practice for the use of Laser in medicine and Surgery, Recommendation Regarding the Laser safety officer, Hospital Laser Committee	**06**
4.	**Optic Fibers Fundamentals** Light transmission in optical fibers- principles, optical properties of optical fibers, Fiber materials, Types of Optical fibers, Modes, Losses, Fabrication of optical fibers, Methods and Principle, Fiber Splicing, Fiber optic imaging, Biomedical Optical fibers, In vivo Applications.	**10**
5.	**Laser and Fiber Optics in surgery** Introduction, fiber optic laser systems in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty, Laser and Fiber optics used in Skin	**06**
6.	**Endoscopy** Basic Principle, System components and functions, Types of endoscopes, Video Endoscopes, Accessories, Maintenance, Endoscopy Processing room requirements, Medical Application, Leakage tester and Trouble shooting	**06**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Lasers and Optical Fibers in Medicine – AbrahimCatzir Academic press 1998
2. Optical Fiber Communication by Gerd Keiser

Reference Books:

1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI
4. Lasers in Urologic Surgery – Joseph A.Smith,Jr, Barry S.Stein, Ralph C.BensonJr, Mosby Pub
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

Theory Examination:

3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6023	Department Level Optional Course- II Biological Modelling and Simulation (Abbreviated as BMS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 6023	Department Level Optional Course - II Biological Modelling and Simulation (BMS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6023	Biological Modelling and Simulation	04
Course Objective	• To provide in-depth knowledge of modelling of physiological systems. • To understand basic concepts of modeling for designing biological model.	
Course Outcome	Learner will be able to: • Explain the concepts, usage and process of physiological modelling • Apply basic biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions • Understand the function of complex closed loop systems like temperature control using modelling. • Understand the function of neuromuscular system with the help of various models. • Understand the function of open loop system like eye movement system and differentiate open loop and closed loop system • Understand the usage of, and the assumptions behind biological models (immune response, drug delivery and insulin glucose feedback) in the working life.	

Module	Detailed Contents	Hours
1.	**Physiological Modelling**: Steps in Modelling, Purpose of Modelling, lumped parameter models, distributed parameter models, compartmental modelling, modelling of circulatory system and respiratory system.	**07**
2.	**Model of Neurons:** Biophysics tools, Equilibrium in a one ion system, Donnan Equilibrium, Space-Charge Neutrality, Membrane with no-zero permeability, GHK equation, Active Transport (Pump), Action Potential, Electrical Equivalent model of a biological membrane, The H-H model, The iron-wire model, Channel Characteristics, Simulation of action potential, voltage propagation in a passive axon (cable equation).	**14**
3.	**Neuromuscular System:** modelling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.	**06**
4.	**Eye Movement Model:** Eye movements, quantitative eye movement models, techniques for validating models, validation of other physiological systems	**12**
5.	**Thermoregulatory systems:** Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application.	**03**
6.	**Modelling of other physiological systems.** **Modelling the Immune response:** Behavior of the immune system, linearized model of the immune response. **Modelling of Drug delivery systems.** **Modelling of Insulin Glucose feedback system** and Pulsatile Insulin secretion.	**06**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML601	Biomedical Monitoring Equipment (BME)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML601	Biomedical Monitoring Equipment (BME)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML601	Biomedical Monitoring Equipment	01
Course Objective	• To understand the basic principles and working of patient monitoring system. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcome	Learner will be able to: • Design and Implement filters for filtering of noise from signals. • Design and Implement Instrumentation amplifier to amplify low amplitude signals. • Design and Implment a regulated power supply. • Design and Implement Pulse Width Modulator. • Undesrtand the working of ECG machine by recording ECG. • Provide a better understanding about foetal monitoring systems. • Test the hearing ability by use of an audiometry.	

Syllabus: Same as that of BMC601 Biomedical Monitoring Equipment(BME).

List of Laboratory Experiments: (Any Seven)

1. Design of Instrumentation amplifier.
2. Implementation of notch filter.
3. Implementation of Bandpass filter
4. Design and implementation of regulated power supply.

5. Design and implementation of Pulse width modulator.
6. Demonstration of ECG machine / monitor.
7. Demonstration of foetal monitor.
8. Demonstration of Blood flow measurement.
9. Testing of hearing ability using Audiometer.
10. Industry / Hospital visit may to be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentations on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

Practical and Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML602	Microprocessors and Microcontrollers (MPMC)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML602	Microprocessors and Microcontrollers (MPMC)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML602	Microprocessors and Microcontrollers	01
Course Objective	• To apply the theoretical concepts of Microcontroller to design practical circuits. • To learn circuit simulation and software simulations and then convert into a working model.	
Course Outcome	Learner will be able to: • Execute the program using microprocessor and microcontroller kits. • Execute assembly and C language programs using simulator. • Apply the knowledge of programming to implement a mini project.	

Syllabus: Same as that of BMC602 Microprocessors and Microcontrollers (MPMC).

List of Laboratory Experiments: (Any four and mini project)

1. To study 8031\8086 kit.
2. To perform experiment on data transfer.
3. To study arithmetic operations.
4. To perform experiment on logical instructions.
5. To perform experiment on Timers\Counters.
6. To study and perform experiment on Square wave generation.
7. To implement LCD interfacing.
8. Mini Project.

Any other experiment based on syllabus which will help students to understand topic/concept

Term Work:

Term work shall consist of minimum 7 experiments. Every year at least 3 experiments should be changed from previous year experiments

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 10 Marks

Mini Project (Implementation and Report) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

2. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
3. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
4. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
5. The 8051 microcontrollers-Kenneth J Ayala
6. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
7. Using MCS-51 Microcontroller Han-Way Huang,.
8. 8051 microcontroller hardware, software applications.V Udayashankara, M S Mallikarjunaswamy

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
4. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication
5. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
6. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
7. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
8. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication.

Practical and Oral examination will be based on mini project.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML603	Digital Image Processing (DIP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML603	Digital Image Processing (DIP)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML603	Digital Image Processing	01
Course Objective	• To introduce the learners the basic theory of digital image processing. • To expose learners to various available techniques and possibilities of this field. • To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. • To prepare learners to formulate solutions to general image processing problems. • To develop hands-on experience in using computers to process images. • To familiarize with MATLAB / C/ Labview/ similar software for processing digital images.	
Course Outcome	Learner will be able to: • Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. • Analyze images in the spatial domain. • Analyze images in the frequency domain through the Fourier transform. • Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing**.**	

Syllabus: Same as that of BMC603 Digital Image Processing (DIP).

List of Laboratory Experiments (Any Seven)

1. Point Processing techniques (At least 4 experiments).
2. Spatial domain Filtering.
3. Histogram Processing (Histogram Stretching and Equalisation).
4. Frequency Domain Filtering (Plotting 2D-DFT, Low pass and High Pass- Ideal, Butterworth and Gaussian Filters).
5. Segmentation-Gradient operators.
6. Transforms-DCT.
7. Morphology-Dilation Erosion.

Any other experiment based on syllabus which will help students to understand topic/concept

Term Work:

Term work shall consist of minimum 7 experiments. Every year at least 3 experiments should be changed from previous year experiments

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Digital Image Processing, Gonzalez and Woods- Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder-Prentice Hall India.

Reference Books:

1. Digital Image Processing and Computer Vision, Sonka, Hlavac, Boyle-Cengage learning.
2. Digital Image Processing, William Pratt- John Wiley.

Practical and Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML604	Medical Imaging - I (MI – I)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML604	Medical Imaging - I (MI – I)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML604	Medical Imaging – I	01
Course Objective	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging.	
Course Outcome	Learner will be able to: • Understand X ray imaging along with X ray tube construction, X ray generators and the total radiographic system. • Understand Fluoroscopic Imaging and Digital Subtraction Angiography • Distinguish between CR and DR. Understand Mammography. • Understand the technique of Computed tomography, the CT scanner configuration, reconstruction techniques and clinical applications. • Apply the knowledge of CT and learn advancements in CT.	

Syllabus: Same as that of BMC604 Medical Imaging – I (MI - I).

List of Laboratory Experiments (Any Seven)

1. Study of X ray tube
2. Study of X ray Tube housing
3. To compare technical specifications of different X ray machines
4. To compare technical specifications of different CT Scanners
5. To generate Sinogram of the image
6. To perform CT windowing on an Image

7. To perform back projection on an Image
8. To generate pseudo colour image
9. To study Fluoroscopy Machine
10. Hospital Visit may be conducted to Radiology Department
11. Presentation on the given topic
12. To generate Research article on the advanced topic
13. Demonstrations/Experts talk

Any other experiment based on syllabus which will help students to understand topic/concept.

Group Presentations on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. Practical Radiotherapy: Physics and equipment: Pam Cherry, Angela Duxbury

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6021	Department Level Optional Course – II Healthcare Software (HCS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6021	Department Level Optional Course – II Healthcare Software (HCS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6021	Healthcare Software	01
Course Objective	• To setup programming environment for ASP.NET programs • To develop modular applications using object oriented methodologies • To configure ASP.NET application and creating applications using standard .NET controls • To develop data driven web application • To connect different data sources and manage them • To maintain session and controls related information in multi-user web applications	
Course Outcome	Learner will be able to: • Understanding of Microsoft .NET Framework and ASP.NET page structure • Designing of windows applications using C#.NET • Designing of web applications using ASP.NET controls • Creating database driven ASP.NET web applications using SQL Server • Debugging and deploying ASP.NET web applications	

Syllabus: Same as that of BMDLO6021 Healthcare Software (HCS).

List of Laboratory Experiments (Any Seven)

1. Develop an ASP.NET application to show all page events along with their order of execution.
2. Develop an ASP.NET application to demonstrate the use of standard ASP.NET controls (TextBox, CheckBox, RadioButton, Button, Image, ImageButton, etc).
3. Develop an ASP.NET application to demonstrate the use of rich ASP.NET controls (use the FileUpload control).
4. Develop an application to demonstrate the use of validation controls in ASP.NET (RequiredFieldValidator, RangeValidator, CompareValidator and RegularExpressionValidator).
5. Develop an ASP.NET web application to demonstrate page themes and master page.
6. Develop an ASP.NET web application to demonstrate session management across application.
7. Develop an ASP.NET web application with Databound controls (List, Tabular, and Hierarchical).
8. Develop an ASP.NET web application to demonstrate use of SQLDataSource control.
9. Develop an ASP.NET web application to demonstrate use of XMLDataSource control.
10. Develop any database driven web application using SQL Server (experiment should demonstrate creation, updating and deletion of records from the database).

Any other experiment based on syllabus which will help students to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. ASP.NET 3.5 Unleashed (Sams) - Stephen Walther
2. Microsoft ASP.NET Step by Step (Microsoft Press) - G. Andrew Duthrie

Reference Books:

1. Designing Microsoft ASP.NET Applications (Microsoft Press) - Jonathon Goodyear, Brian Peek, Brad Fox
2. Deploying and Managing Microsoft .NET Web Farms (Sams) - Barry Bloom

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6022	Department Level Optional Course – II Lasers and Fiber optics (LFO)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6022	Department Level Optional Course – II Lasers and Fiber optics (LFO)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6022	Lasers and Fiber Optics	01
Course Objective	• To understand the fundamentals in Laser and Fiber Optics. • To understand the applications of Laser and Fiber optics in health sector.	
Course Outcome	Learner will be able to: • Understand the fundamentals and clinical applications of Laser and Fiber Optics. • Correlate the knowledge of medicine and engineering for the wellness of human being. • Understand the safety aspects while dealing with Laser and Fiber Optic Units.	

Syllabus: Same as that of BMDLO6022 Lasers and Fibre Optics(LFO).

Laboratory work:

1. Demonstrations in hospital / Industry.
2. Discussion on research articles and recent developments in the field of medicine.
3. Group ppresentations on the latest technology in hospitals based on the topics covered in the syllabus.
4. 5 Assignments based on the entire syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work : 10 Marks
Laboratory work (Documentation) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Lasers and Optical Fibers in Medicine – AbrahimCatzir Academic press 1998
2. Optical Fiber Communication by Gerd Keiser

Reference Books:

1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI
4. Lasers in Urologic Surgery – Joseph A.Smith,Jr, Barry S.Stein, Ralph C.BensonJr, Mosby Pub
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

Oral examination will be based on entire syllabus

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6023	Department Level Optional Course – II Biological Modelling and Simulation (BMS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6023	Department Level Optional Course – II Biological Modelling and Simulation (BMS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6023	Biological Modelling and Simulation	01
Course Objective	• To understand basic approach of modeling for designing biological model. • To simulate physiological processes for better understanding. • To develop competency in terms of logical thinking, programming and application skills • To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcome	Learner will be able to: • Apply concept of physiological modelling to model thermometer system. • Virtually understand biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions. • Simulate mathematical model for the eye movement • Electrically simulate model of thermoregulatory system • Understand the usage of, and the assumptions behind biological models	

	(immune response, drug delivery and insulin glucose feedback) in the working life.

Syllabus: Same as that of BMDLO6023 Biological Modelling and Simulation (BMS).

List of Laboratory Experiments (Any Seven)

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB
3. Simulation of eye movement using MATLAB
4. Simulation using HHSim **(Two practicals)**
5. Simulation using Neurons in Action **(Two practicals)**
6. Developing a model of a neuron using NEURON
7. Electrical simulation of thermoregulatory model

Any other experiment / assignment / presentation based on syllabus which will help students to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Oral examination will be based on suggested practical list and entire syllabus

AC

Item No.

UNIVERSITY OF MUMBAI

Revised Syllabus for the

Biomedical Engineering

(Final Year – Semester VII and VIII)

(As per Choice Based Credit and Grading System
with effect from the academic year 2019–2020)

Program Structure for
B.E. Biomedical Engineering
University of Mumbai
(With effect from academic year 2019 - 20)

Scheme for Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC701	Life Saving and Surgical Equipment	04	----	----	04	----	----	04
BMC702	Basics of VLSI	04	----	----	04	----	----	04
BMC703	Medical Imaging-II	04	----	----	04	----	----	04
BMDLO703X	Department Level Optional Course – III	04	----	----	04	----	----	04
ILO101X	Institute Level Optional Course – I	03	----	----	03	----	----	03
BML701	Life Saving and Surgical Equipment	----	02	----	----	01	----	01
BML702	Basics of VLSI	----	02	----	----	01	----	01
BML703	Medical Imaging-II	----	02	----	----	01	----	01
BMDLL703X	Department Level Optional Course Laboratory – III	----	02	----	----	01	----	01
BML704	Project Stage I	----	06	----	----	03	----	03
Total		**19**	**14**	----	**19**	**07**	----	**26**

Examination Scheme for Semester VII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC701	Life Saving and Surgical Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC702	Basics of VLSI	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC703	Medical Imaging-II	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 703X	Department Level Optional Course - III	80	32	20	8	---	---	---	---	---	---	---	---	100
ILE101X	Institute Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML701	Life Saving and Surgical Equipment	---	---	---	---	25	10	---	---	25	10	---	---	50
BML702	Basics of VLSI	---	---	---	---	25	10	---	---	25	10	---	---	25
BML703	Medical Imaging-II	---	----	---	---	25	10	---	---	25	10	---	---	50
BMDLL 703X	Department Level Optional Course Laboratory – III	---	---	---	---	25	10	---	---	25	10	---	---	25
BML704	Project Stage I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**125**	**50**	**---**	**---**	**125**	**50**			**700**

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC801	Biomedical Microsystems	04	----	----	04	----	----	04
BMC802	Hospital Management	04	----	----	04	----	----	04
BMDLO804X	Department Level Optional Course – IV	04	----	----	04	----	----	04
ILO202X	Institute Level Optional Course – II	03	----	----	03	----	----	03
BML801	Biomedical Microsystems	----	02	----	----	01	----	01
BML802	Hospital Management	----	02	----	----	01	----	01
BMDLL804X	Department Level Optional Course Laboratory – IV	----	02	----	----	01	----	01
BML803	Project Stage II	----	12	----	----	06	----	06
Total		**15**	**18**	----	**15**	**09**	----	**24**

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC801	Biomedical Microsystems	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC802	Hospital Management	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 801X	Department Level Optional Course - IV	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO202X	Institute Level Optional Course –II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML801	Biomedical Microsystems	---	---	---	---	25	10	---	---	25	10	---	---	50
BML802	Hospital Management	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 801X	Department Level Optional Course Laboratory – IV	---	----	---	---	25	10	---	---	25	10	---	---	25
BML803	Project Stage II	---	---	---	---	50	20	---	---	---	---	50	20	100
Total		**320**	**128**	**80**	**32**	**125**	**50**	**---**	**---**	**75**	**30**	**50**	**20**	**625**

Course Code	Department level Optional Course – III
BMDLO7031	Networking and Information in Medical System
BMDLO7032	Advanced Image Processing
BMDLO7033	Embedded Systems

Course Code	Department level Optional Course – IV
BMDLO8041	Health Care Informatics
BMDLO8042	Robotics in Medicine
BMDLO8043	Nuclear Medicine

Course Code	Institute level Optional Course – I
ILO1011	Product Lifecycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management and Mitigation Measures
ILO1018	Energy Audit and Management

Course Code	Institute level Optional Course - II
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC701	Life Saving and Surgical Equipment (Abbreviated as LSSE)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC701	Life Saving and Surgical Equipment (LSSE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC701	Life Saving Equipment	04
Course Objectives	• To understand the basic principles and working of life Saving Equipment. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcomes	**Learner will be able to…** • Distinguish between the types of pacemakers on the basis of ICHD code and analyze the various circuits. • Apply the knowledge of electronics to analyze defibrillator circuits. • Explain the importance of use of Anesthesia machine and Capnograph during Surgery. • Explain the basic principle, working and applications of surgical equipment with safety aspects. • Explain the importance of measurement of oxygen saturation in human body and application of heart lung machine during surgery. • Demonstrate the knowledge of lithotripsy technique.	

Module	Contents	Hours
1	**Cardiac Pacemakers** Need for a pacemaker, modes of operation, Classification codes for pacemaker, External and Implantable Pacemaker, programmable pacemaker, Power sources for pacemakers, leads and electrodes, recent developments of Implantable Pacemakers.	10
2	**Cardiac Defibrillator** Need for Defibrillator, DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, Implantable defibrillator , cardioverter.	10
3	**Anesthesia** Need for anesthesia, Anesthesia machine: Gas supply, flow and delivery system Vapor delivery and humidification and patient breathing Capnography.	06
4	**Surgical equipment** Operation theatre Lights and Table. Surgical Diathermy machine, automated electrosurgical systems, electrodes used with surgical diathermy, safety aspects in electronic surgical units.	10
5	**Oximeters + Heart Lung machine** Basics of oximeter, In-vitro and In-vivo oximetry, ear oximetry, pulse oximetry, skin reflectance oximeters, intravascular oximeters, Heart Lung Machine and types of oxygenators	08
6	**Lithotriptors** The stone disease problem, the shock-wave, the first lithotriptor machine, modern lithotriptor system, LASER Lithotripsy	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC702	Basics of VLSI (Abbreviated as BVLSI)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC702	Basics of VLSI (BVLSI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC702	Basics of VLSI	04
Course Objectives	• To introduce to various fabrication technologies for electronic devices. • To expose to hardware description language which will help them to understand and design various tools for the devices.	
Course Outcomes	A Learner will be able to • Understand hardware description language used to model circuits • Implement some basic digital circuits using HDL • Understand the physics of MOS devices • Understand the implementation of inverter circuits using CMOS devices and noise in these circuits • Understand the fabrication technology used in IC fabrication and how system clocking is designed. • Understand the design rules and layouts for various digital gates	

Module	Contents	Hours
1.	Introduction to VHDL hardware description language, core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architecture.	04
2.	Combinational and Sequential Logic design using VHDL .Using VHDL combinational circuit design examples- multipliers, decoders and encoders, cascading comparator. VHDL sequential circuit design features.	08

	Implementation of counters and registers in VHDL	
3.	Very Large Scale Integration (VLSI) Technology Physics of NMOS, PMOS, enhancement and depletion mode transistor, MOSFET, threshold voltage, flatband condition, linear and saturated operation, FET capacitance, short channel and hot electron effect.	**08**
4.	MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active load nMOS inverter, MOSFET Inverter with E-nMOS as pull up, MOSFET Inverter with D- nMOS as pull up, MOSFET Inverter with pMOS as pull up, CMOS inverter, voltage transfer characteristics, noise immunity and noise margins, power and area considerations ,Parameter measurement in MOS circuits	**08**
5.	Silicon Semiconductor Technology Wafer processing, mask generation, oxidation, epitaxy growth diffusion, ion implantation, lithography, etching, metalization, basic NMOS and PMOS processes. Latch up in CMOS and CMOS using twin tub process. Scaling of MOS circuits, types of scaling and limitations of scaling. Introduction to VLSI Clocking and System Design: Clocking: CMOS clocking styles, Clock generation, stabilization and distribution. Low Power CMOS Circuits: Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling.	**10**
6.	Design rules and Layout NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits Design of circuits like multiplexer, decoder, Flip flops, using MOS circuits	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, first edition, 1990
2. Basic VLSI Design D.A. Pucknell and Eshraghian,
3. Digital Design Principles and Practises John F Wakerly,
4. CMOS Digital Integrated Circuits, Kang , Tata McGraw Hill Publications

Reference Books:

1. VHDL Programming by Examples Douglas Perry, , Tata McGraw Hill Publications, 2002
2. Principles of CMOS VLSI Design : ASystems Perspective Neil H.E. Weste, Kamran Eshraghian second edition, Addison Wesley Publications, 1993
3. Digital Integrated Circuits: A Desiqn Perspective, Rabaey Jan M., Chandrakasan Anantha, Nikolic Borivoje, second edition, Prentice Hall of India

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC703	Medical Imaging - II (Abbreviated as MI – II)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC703	Medical Imaging - II (MI – II)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC703	Medical Imaging II	04
Course Objectives	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging	
Course Outcomes	**Learner will be able to…** • Understand use of Ultrasound in medicine, distinguish various ultrasonic display system, understand the construction and operation of the ultrasonic transducer, understand the clinical applications of Doppler Techniques • Apply the basic concepts of physics in understanding Physics of MRI • Understand the hardware of MRI Machine, Spin echo Imaging, Pulse sequence, image reconstruction, resolution and SNR, Biological effects and clinical applications • To understand the basic principle of Magnetic Resonance Spectroscopy • To understand nuclear imaging techniques and positron emission tomography and apply the concepts to understand hybrid imaging • To understand Endoscopy	

Module	Contents	Hours
1	**Ultrasound in Medicine:** Introduction , Production and Characteristics of Ultrasound Display System: A mode, B mode and M Mode, TM mode display and applications. Ultrasound transducers and Instrumentation. Real time Ultrasound ,Continuous wave and Pulsed Doppler, 2D-Echo Clinical applications	**12**
2	**Physics of MRI**: Magnetic Dipole Moments, Relaxation Parameters, Spin Echo, Magnetic Field Gradients, Slice selection, Phase and Frequency Encoding	**06**
3	**Magnetic Resonance Imaging** Hardware: Magnets, Gradient coils, RF coils, Spin Echo Imaging, Inversion Recovery Pulse Sequence, Image Reconstruction, Resolution and Factors affecting signal-to-noise. Safety Considerations and Biological Effects of MRI, Clinical applications	**12**
4	**Magnetic Resonance Spectroscopy (MRS)** Basic Principle of MRS and localization techniques, Chemical Shift Imaging, Single-voxel and Multivoxel MRS, Water Suppression techniques	**06**
5	**Hybrid Imaging** Introduction, Principles and applications of PET and SPECT, Introduction to Hybrid Modalities: PET/CT, SPECT/CT Clinical Applications	**08**
6	**Endoscopy** Equipment , Imaging and its applications	**04**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. The essential physics of Medical Imaging- Jerrold T. Bushberg, J. Anthony Seibert, Edwin L, John Boone

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO7031	Department Level Optional Course - III: Networking and Information in Medical Systems (Abbreviated as NIMS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 7031	Networking and Information in Medical Systems (NIMS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO7031	Networking and Information in Medical Systems	04
Course Objectives	• To understand the fundamental component of computer Networking. • To understand the functioning and configuration of various networking devices and components. • To understand a concept about network security. • Understand various Information system used in Healthcare System • To understand the healthcare IT infrastructure Understand various IHE domains	
Course Outcomes	**Learners will be able to:** • Understand the fundamental components of computer networks and networking protocols. • Understand IP addressing, functioning and configuration of various networking devices and components • Understand concepts about network security • Understand the PACS components, architecture and PACS tele radiology	

	• Understand HIS, RIS integration of HIS/RIS/PACS, PACS archive and servers • Understand IHE and IHE domains

Module	Contents	Hours
	Networking Technology	
1	Performance of network/device parameters: Bandwidth, Throughput, Jitter, Latency Network Technology, Types of cables and connectors, Crossover and straight through cables, Colour coding of cables, OSI Model, TCP/IP, Addressing types (IP, MAC & Port)	**08**
2	IP V4 addressing, Subnetting, Supernetting, IP V6, Detailed working of networking equipment: HUB, Switch, Router, Modem, Bridge; Packet switching, Circuit switching.	**08**
3	Basic Security Concepts Security Mechanism and security services, Authentication, Authorization, Confidentiality, Integrity, Symmetric and Asymmetric Key cryptography, RSA algorithm	**06**
	Information Systems in Medicine	
4	PACS Components, Generic workflow, PACS architectures: stand-alone, client-server, and Web-based, PACS and Teleradiology, Enterprise PACS and ePR System with Image Distribution	**10**
5	Introduction to RIS and HIS, HIS/RIS/PACS integration, PACS Archive Storage: RAID, PACS Server, Fault Tolerant PACS, HIPPA	**08**
6	Integrating Healthcare Enterprise: IHE Workflow Model, IHE Domains, IHE Patient Information Reconciliation Profile, IHE Radiology Information Integration Profile	**08**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. PACS and Imaging Informatics by Huang, Second Edition, Wiley and Blackwell
2. PACS Guide to Digital Revolution by Keith J. Dreyer (Springer)
3. Data Communication and Networking by Behrouz A. Forouzan McGrow Hill
4. Computer Networks by A.S. Tanenbaum, Pearson Education

Reference Books:

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong (Medical

Information Science Reference)
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer
3. PACS fundamentals- By Herman Oosterwijk
4. Cryptography and Network Security By William Stalling, Pearsons

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO7032	Department Level Optional Course - III: Advanced Image Processing (Abbreviated as AIP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 7032	Advanced Image Processing (AIP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO7032	Advanced Image Processing	04
Course Objectives	• To introduce the learners to advanced theory of digital image processing. • To expose learners to various available techniques and possibilities of this field. • To understand the various techniques & algorithms such as Colour imaging, Feature extraction, Restoration, Texture and Application • To prepare learners to formulate solutions to Complex image processing Algorithms • To develop programming skills to solve complex Image Processing Problems	
Course Outcomes	**Learner will be able to …** • Acquire the advanced concepts of a digital image processing system such as Colour imaging, Feature extraction, Restoration, Texture and Application • Extract feature and classify images. • Design Image restoration and segmentation using various complex algorithms. • Strategize and implement with MATLAB/C/SCILAB algorithms for advanced digital image processing operations.	

Module	Contents	Hours
1	**Colour Image Processing:** Introduction, Physics of Colour, Colour Models, Pseudo Colouring, Colour Histograms, Colour Segmentation	08
2	**Feature recognition and classification:** Object recognition and classification, Connected components labelling, Features, Object recognition and classification, Statistical classification, Structural/syntactic Classification, Applications in medical image analysis. Three-dimensional: visualization: Image visualization , Surface rendering, Volume rendering,	10
3	**Image restoration:** Image degradation, Noise, Noise-reduction filters, Blurring, Modeling image degradation, Geometric degradations, Inverse filtering, Wiener Filter, Geometric Mean filter, Geometric Transformation	08
4	**Advanced Image of Image Segmentation:** Canny edge detectors, Clustering methods, Classifiers, Watershed Algorithm, Top Hat and Bottom Hat Transformation	10
5	**Texture:** Grey Level Co-Occurrence Matrix, Energy, entropy, maximum probability, Laplacian and Gaussian pyramid, Texels and Texel based descriptors.	06
6	**Wavelet Transform and Application:** Basics of 1-D, 2-D DWT, Wavelet Pyramids, Computer-aided diagnosis in mammography, Tumour imaging and treatment, Angiography, Bone strength and osteoporosis, Tortuosity	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Digital Image Processing for Medical Applications, GEOFF DOUGHERTY, Cambridge University Press.
2. Digital Image Processing, Gonzalez and Woods, Pearson Eduction
3. Image Processing analysis and Machine Vision, Milind Sonka et.al Cengage

Reference Books:

1. Computer Vision, Linda Shapiro et.al Addison-Wesley
2. Computer Vision a Modern Approach, David A. Forsyth, Jean Ponce, Pearson

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO7033	Department Level Optional Course - III: Embedded Systems (Abbreviated as ES)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 7033	Embedded Systems (ES)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO7033	Embedded Systems in Biomedical Engineering	04
Course Objectives	• To provide an introduction to modern embedded systems • To understand the design, implementation and programming of modern real time embedded systems.	
Course Outcomes	**Learner will be able to** • To become aware of the embedded hardware and software components in an embedded system, classification, skills required for an embedded system designer and applications of modern embedded systems. • To analyse the design and development process of embedded systems. • To understand the I/O devices, communication buses and distributed networked embedded architecture. • To understand the concepts of device drivers and interrupt service mechanisms • To understand RTOS. • To understand the basic design and programming using RTOS.	

Module	Contents	Hours
1	Introduction to Embedded System	05

	Definition, Processor Embedded into a system, Embedded Hardware, Embedded Software, Embedded-system Design, Embedded-system Architecture, Embedded-system Model, Classification, Skills required for an ES designer, Examples of Embedded-system	
2	**Embedded System Design & Development Process** Embedded System-On-Chip, Complex System Design and Processors, Build Process, Design Process, Design Challenges and Optimization of Design Metrics, Embedded-Software Development Challenges, Hardware Software Co-Design, Formalism of System Design, Design Process and Design Examples	**10**
3	**I/O Devices, Communication Buses and Distributed Networked Embedded Architecture** I/O Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features, Wireless Devices, Timer and Counting Devices, Distributed Network ES Architecture, Serial Bus Communication Protocols, Parallel Bus Device Protocols- Using ISA, PCI, PCI-X and Advanced Buses, Internet Enabled Systems, Wireless and Mobile System Protocols	**08**
4	**Device Drivers and Interrupts Service Mechanism** Port for Device Accesses without Interrupts Servicing Mechanism, Interrupt Driven I/O, Interrupt Service Routine, Interrupt Sources, Hardware and Software Interrupts, Interrupt-servicing Mechanism, Multiple Interrupts, Interrupt Service Threads, Context and Period for Context Switching, Interrupt Latency, Interrupt-Service Deadline, Classification of Interrupt Service Mechanism, Direct Memory Access Driven I/O	**07**
5	**Introduction to RTOS** Introduction to Round Robin, Round Robin with Interrupts, Real-Time Operating System Architecture, Selecting an Architecture, Task and Task States and Data, Semaphores and Shared Data	**08**
6	**Basic Design using RTOS & Programming** Overview, Principles, Encapsulating Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory Space, Saving Power, Case Study	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Embedded System Architecture, Programming & Design (Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon

Reference Books:

1. Embedded Real time Systems Programming- Sriram V Iyer, Pankaj Gupta

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.

2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1011	Institute Level Optional Course - I: Product Life Cycle Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1011	Institute Level optional Course -I: Product Life Cycle Manag-ement	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1011	Product Life Cycle Management	03
Course Objectives	• To familiarize the students with the need, benefits and components of PLM • To acquaint students with Product Data Management & PLM strategies • To give insights into new product development program and guidelines for designing and developing a product • To familiarize the students with Virtual Product Development	
Course Outcomes	**Learner will be able to…** • Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. • Illustrate various approaches and techniques for designing and developing products. • Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. • Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan	

Module	Contents	Hours
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	12
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	06
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	06
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Theory Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1012	Institute Level Optional Course- I: Reliability Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1012	Institute Level Optional Course -I: Reliability Engineering	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1012	Reliability Engineering	03
Course Objectives	• To familiarize the students with various aspects of probability theory • To acquaint the students with reliability and its concepts • To introduce the students to methods of estimating the system reliability of simple and complex systems • To understand the various aspects of Maintainability, Availability and FMEA procedure.	
Course Outcomes	**Learner will be able to** • Understand and apply the concept of Probability to engineering problems • Apply various reliability concepts to calculate different reliability parameters • Estimate the system reliability of simple and complex systems • Carry out a Failure Mode Effect and Criticality Analysis	

Module	Contents	Hours
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**10**
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**10**
03	**System Reliability** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**05**
04	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**10**
05	**Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	**05**
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	**05**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Theory Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1013	Institute Level Optional Course - I: Management Information System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO1013	Institute Level Optional Course -I: Management Information System	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1013	Management Information System	03
Course Objectives	• The course is blend of Management and Technical field. • Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built • Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage • Identify the basic steps in systems development • Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management • Discuss critical ethical and social issues in information systems	
Course Outcomes	**Learner will be able to** • Explain how information systems Transform Business • Identify the impact information systems have on an organization • Describe IT infrastructure and its components and its current trends • Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making • Identify the types of systems used for enterprise-wide knowledge management	

	and how they provide value for businesses

Module	Detailed Contents	Hours
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	**07**
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	**09**
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	**06**
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	**07**
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	**06**
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	**10**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. Management Information Systems: Kelly Rainer, Brad Prince by Wiley
2. Management Information Systems: Managing the Digital Firm (10th Edition). K.C. Laudon and J.P. Laudon, Prentice Hall, 2007.

3. Managing Information Systems: Strategy and Organization, D. Boddy, A. Boonstra, Prentice Hall, 2008

Theory Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1014	Institute Level Optional Course - I: Design of Experiments	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1014	Institute Level Optional Course -I: Design of Experiments	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1014	Design of Experiments	03
Course Objectives	• To understand the issues and principles of Design of Experiments (DOE). • To list the guidelines for designing experiments. • To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization	
Course Outcomes	**Learner will be able to** • Plan data collection, to turn data into information and to make decisions that lead to appropriate action. • Apply the methods taught to real life situations. • Plan, analyze, and interpret the results of experiments	

Module	Detailed Contents	Hours
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in	08

	Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	**07**
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	**07**
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	**07**
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	**04**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill.
7. Madhav S Phadake, "Quality Engineering using Robust Design," Prentice Hall.

Theory Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1015	Institute Level Optional Course - I: Operations Research	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1015	Institute Level Optional Course -I: Operations Research	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1015	Operations Research	03
Course Objectives	• Formulate a real-world problem as a mathematical programming model. • Understand the mathematical tools that are needed to solve optimization problems. • Use mathematical software to solve the proposed models.	
Course Outcomes	**Learner will be able to…** • Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. • Understand the relationship between a linear program and its dual, including strong duality and complementary slackness. • Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. • Solve specialized linear programming problems like the transportation and assignment problems.	

	• Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. • Understand the applications of, basic methods for, and challenges in integer programming • Model a dynamic system as a queuing model and compute important performance measures

Module	Detailed Contents	Hours
01	**Introduction to Operations Research***:* Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research	**02**
02	**Linear Programming***:* Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, ***Duality***, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	**06**
03	**Transportation Problem***:* Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem***:* Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	**06**
04	**Integer Programming Problem***:* Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	**06**
05	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	**06**

06	**Simulation***:* Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**04**
07	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	**04**
08	**Games Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**04**
09	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	**04**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Theory Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1016	Institute Level Optional Course - I: Cyber Security and Laws	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1016	Institute Level Optional Course -I: Cyber Security and laws	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1016	Cyber Security and Laws	03
Course Objectives	• To understand and identify different types cyber crime and cyber law • To recognized Indian IT Act 2008 and its latest amendments • To learn various types of security standards compliances	
Course Outcomes	**Learner will be able to** • Understand the concept of cyber crime and its effect on outside world • Interpret and apply IT law in various legal issues • Distinguish different aspects of cyber law • Apply Information Security Standards compliance during software design and development	

Module	Detailed Contents	Hours
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	**04**
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	**10**
03	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	**06**
04	**The Concept of Cyberspace:** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	**08**
05	**Indian IT Act.:** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments	**08**
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	**06**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security* &*Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Theory Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1017	Institute Level Optional Course - I: Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1017	Institute Level Optional Course -I: Disaster Management and Mitigation Measures	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1017	Disaster Management and Mitigation Measures	03
Course Objectives	• To understand the various types of disaster occurring around the world • To identify extent and damaging capacity of a disaster • To study and understand the means of losses and methods to overcome /minimize it. • To understand role of individual and various organization during and after disaster • To know warning systems, their implementation and based on this to initiate training to a laymen • To understand application of GIS in the field of disaster management • To understand the emergency government response structures before, during and after disaster	
Course Outcomes	**Learner will be able to** • Understand natural as well as manmade disaster and their extent and possible effects on the economy.	

	• Planning of national importance structures based upon the previous history. • Understand government policies, acts and various organizational structure associated with an emergency. • Know the simple do's and don'ts in such extreme events and act accordingly

Module	Detailed Contents	Hours
01	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	**03**
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	**06**
03	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	**06**
04	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	**06**
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects	**09**

	related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	**06**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P. Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1018	Institute Level Optional Course - I: Energy Audit and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO1018	Institute Level Optional Course -I: Energy Audit and Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO1018	Energy Audit and Management	03
Course Objectives	• To understand the importance energy security for sustainable development and the fundamentals of energy conservation. • To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management • To relate the data collected during performance evaluation of systems for identification of energy saving opportunities	
Course Outcomes	**Learner will be able to** • To identify and describe present state of energy security and its importance. • To identify and describe the basic principles and methodologies adopted in energy audit of an utility. • To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. • To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities • To analyze the data collected during performance evaluation and recommend energy saving measures	

Module	Detailed Contents	Hours
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	**04**
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	**08**
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	**10**
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	**10**
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	**04**
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	**03**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Theory Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO1019	Institute Level Optional Course - I: Development Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Credits
ILO1019	Development Engineering	03
Course Objectives	• To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural • To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas • An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals • To understand the Nature and Type of Human Values relevant to Planning Institutions	
Course Outcomes	**Learner will be able to** • Apply knowledge for Rural Development • Apply knowledge for Management Issues. • Apply knowledge for Initiatives and Strategies. • Develop acumen for higher education and research. • Master the art of working in group of different nature. • Develop confidence to take up rural project activities independently.	

Module	Detailed Contents	Hours
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development. Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local. Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04

03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**
04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

REFERENCES:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.

9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and
Practice, Vol. 4, No.4, pp.395 – 407

Theory Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML701	Life Saving and Surgical Equipment (LSSE)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML701	Life Saving and Surgical Equipment (LSSE)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML701	Life Saving and Surgical Equipment	01
Course Objectives	• To understand the basic principles and working of life Saving Equipment. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcomes	**Learner will be able to…** • Design and implement basic Pacemaker circuits. • Design and implement basic oscillator circuits for Surgical Diathermy. • Demonstration the knowledge of application techniques of physiotherapy machines. • Demonstrate the knowledge of application technique of oximeter	

Syllabus: Same as that of BMC701 Life Saving and Surgical Equipment (LSSE).

List of Experiments: (Any Seven)

1. Implementation and testing of basic circuit of pacemaker.
2. Implementation of NAND Gate Oscillator in Surgical Diathermy.
3. Implementation of RLC Over damped system.
4. Implementation of OT lights.
5. Demonstration of Defibrillator.
6. Demonstration of Pacemaker.
7. Demonstration of Surgical Diathermy.
8. Demonstration of Oximeter.
9. Industry / Hospital visits may be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML702	Basics of VLSI (BVLSI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML702	Basics of VLSI (BVLSI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML702	Basics of VLSI	01
Course Objective	• To expose to hardware description language which will help them to understand and design various tools for the devices.	
Course Outcome	A Learner will be able to • Understand hardware description language used to model circuits • Implement some basic digital circuits using HDL • Understand the physics of MOS devices • Understand the implementation of inverter circuits using CMOS devices and noise in these circuits • Understand the design rules and layouts for various digital gates	

Syllabus: Same as that of BMC702 Basics of VLSI (BVLSI).

List of Experiments: (Any Seven)

1. Study of NMOS CW modulation of NMOS channel (Using ORCAD or similar software)
2. Study of CMOS Inverter characteristics (Using ORCAD or similar software)
3. Basic Logic gates (using VHDL)
4. Binary to gray and Gray to Binary code conversion(using VHDL)
5. Binary to Excess-3 code conversion(using VHDL)
6. Implementation of 4:1/8:1 Mux(using VHDL)
7. Implementation of 3:8 Decoder(using VHDL)
8. Implementation of one bit Half Adder a Full adder (using VHDL)
9. Implementation of 4 bit full adder using half adder as component(using VHDL)

10. Implementation of JK flip flop(using VHDL)

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, first edition, 1990
2. Basic VLSI Design D.A. Pucknell and Eshraghian,
3. Digital Design Principles and Practises John F Wakerly,
4. CMOS Digital Integrated Circuits, Kang , Tata McGraw Hill Publications

Reference Books:

1. VHDL Programming by Examples Douglas Perry, , Tata McGraw Hill Publications, 2002
2. Principles of CMOS VLSI Design : ASystems Perspective Neil H.E. Weste, Kamran Eshraghian second edition, Addison Wesley Publications, 1993
3. Digital Integrated Circuits: A Desiqn Perspective, Rabaey Jan M., Chandrakasan Anantha, Nikolic Borivoje, second edition, Prentice Hall of India

Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML703	Medical Imaging - II (MI - II)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML703	Medical Imaging - II (MI - II)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML703	Medical Imaging - II	01
Course Objective	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging	
Course Outcome	Learner will be able to • Understand the construction and working of ultrasound transducer • Understand the instrumentation and applications of Endoscopy • Apply the knowledge of Image processing in reconstructing the medical images • Understand the basic principles of MRI Physics and Nuclear imaging • Understand the concept of Hybrid Imaging.	

Syllabus: Same as that of BMC703 Medical Imaging – II (MI – II).

List of Experiments: (Any Seven)

1. Study experiment of Ultrasound Transducer
2. Demonstration on Endoscopy
3. MRI reconstruction using Fourier Transform
4. Image fusion for Hybrid Imaging
5. Calculation of T2 from T2* given ΔB and and plot the equations in graph.

6. Presentations based on given topics
7. Hospital Visits
8. Seminars by expert speakers
9. Research on advanced topics

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. The essential physics of Medical Imaging- Jerrold T. Bushberg, J. Anthony Seibert, Edwin L, John Boone

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 7031	Networking and Information in Medical Systems (NIMS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 7031	Networking and Information in Medical System (NIMS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL 7031	Networking and Information in Medical System	01
Course Objective	• To understand the fundamental component of computer Networking. • Configure various networking devices and components. • To understand a concept about network security. • Understand various Information system used in Healthcare System • To understand the healthcare IT infrastructure Understand various IHE domains	
Course Outcome	Learner will be able to • Configure various networking devices and components • Design Basic Network using IP addressing and devices • Design data flow in Hospital Using IHE Domain.	

Syllabus: Same as that of BMDLO7031 Networking and Information in Medical System (NIMS)

List of Experiments: (Any four and mini project)

1. Study of various networking cables, demonstration of crimping of cables and configuring networking parameters for computer.
2. Tutorial on IP addressing.
3. Introduction and basic commands used in various network simulation software.

4. Internetwork Communcation through Router and Switch, See the Mac Table of each switch and Routing table of Router
5. Static routing configuration.
6. Case study of IHE domain

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Case study) : 10 Marks
Laboratory work (Mini Project) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. PACS and Imaging Informatics by Huang, Second Edition, Wiley and Blackwell
2. PACS Guide to Digital Revolution by Keith J. Dreyer (Springer)
3. Data Communication and Networking by Behrouz A. Forouzan McGrow Hill
4. Computer Networks by A.S. Tanenbaum, Pearson Education

Reference Books:

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong (Medical Information Science Reference)
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer
3. PACS fundamentals- By Herman Oosterwijk
4. Cryptography and Network Security By William Stalling, Pearsons

Oral examination will be based on the entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 7032	Advanced Image Processing (AIP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 7032	Advanced Image Processing (AIP)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL7032	Advanced Image Processing	01
Course Objective	• To introduce the learners to advanced theory of digital image processing. • To understand the various techniques & algorithms such as Colour imaging, Feature extraction, Restoration, Texture and Application • To prepare learners to formulate solutions to Complex image processing Algorithms • To develop programming skills to solve complex Image Processing Problems.	
Course Outcome	**Learner will be able to** • Acquire the advanced concepts of a digital image processing system such as Colour imaging, Feature extraction, Restoration, Texture and Application • Extract feature and classify images. • Strategize and implement with MATLAB/C/SCILAB algorithms for advanced digital image processing operations.	

Syllabus: Same as that of BMDLO7032 Advanced Image Processing (AIP).

List of Experiments: (Any Seven)

1. Transition of Colour Models
2. Pseudo Colouring
3. Filtering of Colour Images

4. Canny Edge Detector
5. Watershed Algorithm
6. Top Hat Transformation
7. Bottom Hat Transformation
8. Wavelet Decomposition
9. Geometric Mean Filter
10. K means clustering

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Case study) : 10 Marks
Laboratory work (Mini Project) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Digital Image Processing for Medical Applications, GEOFF DOUGHERTY, Cambridge University Press.
2. Digital Image Processing, Gonzalez and Woods, Pearson Eduction
3. Image Processing analysis and Machine Vision, Milind Sonka et.al Cengage

Reference Books:

1. Computer Vision, Linda Shapiro et.al Addison-Wesley
2. Computer Vision a Modern Approach, David A. Forsyth, Jean Ponce, Pearson

Oral examination will be based on the entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 7033	Embedded Systems (ES)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 7033	Embedded Systems (ES)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL7033	Embedded Systems	01
Course Objective	• Design, implementation and programming of a basic modern embedded system.	
Course Outcome	Learner will be able to • To become aware of embedded hardware and software components in an embedded system. • To analyze the design and development process of embedded systems. • To understand the design, implementation and programming of a real world embedded system (case study).	

Syllabus: Same as that of BMDLO7033 Embedded Systems (ES).

List of Experiments: (Any four and mini project)

1. Biotelemetry system,
2. Portable patient monitoring system (ECG, heart rate, blood pressure, pulse oximeter)
3. Glucometer,
4. Robotic arm in surgeries
5. Automated wheelchair,
6. Drug delivery system (syringe pump),
7. Fall detection system for elderly,
8. CT/MRI bed.
9. Embedded system course project.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Case study) : 10 Marks
Laboratory work (Mini Project) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Embedded System Architecture, Programming & Design (Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon

Reference Books:

1. Embedded Real time Systems Programming- Sriram V Iyer, Pankaj Gupta

Oral examination will be based on mini project.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML704	Project Stage - I	--	06	--	--	03	--	03

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML 704	Project Stage - I	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML704	Project Stage-I	03
Course objective	• To apply the knowledge gained during Curriculum to develop and design problem statement. • Conduct literature survey. • Design Circuit/ Flow chart of the statement. • Documentation and project report writing.	
Course Outcome	**Learner will be able to** • Review literature to define problem statement • Apply knowledge of the engineering fundamentals acquired during the curriculum and beyond • Develop and create design using appropriate design methodologies considering the various health, society and environmental needs. • Write problem statement, Design concept in prescribed format. • Learn the behavioral science by working in a group.	

Project Guidelines:

1. Learner is allotted 6 hrs per week for the project work
2. Learners should carry out literature survey /visit industry / analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor.
3. Group of maximum four students will be completing a comprehensive project work.
4. Learners should use multiple literatures and understand the problem.
5. Learners should attempt solution to the problem by experimental/simulation methods.
6. The solution to be validated with proper justification and compile the report in standard format

7. Learner may use this opportunity to learn different computational techniques as well as some model development.

Faculty Load:

1. In semester VII – 1/2 (half) period of 1/2 hour per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups

Assessment:

Term Work:

Term Work should be examined by approved internal faculty appointed by the head of the institute based on the following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

Guidelines for Assessment of Project Stage- I

1. Project I should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
2. Project stage I should be assessed based on following points
   - Quality of problem selected
   - Literature Survey
   - Clarity of Problem definition and Feasibility of problem solution
   - Relevance to the specialization / Industrial trends
   - Clarity of objective and scope
   - Quality of Project Design
   - Compilation of Project Report
   - Quality of Written and Oral Presentation

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC801	Biomedical Microsystems	04	----	----	04	----	----	04
BMC802	Hospital Management	04	----	----	04	----	----	04
BMDLO804X	Department Level Optional Course – IV	04	----	----	04	----	----	04
ILO202X	Institute Level Optional Course – II	03	----	----	03	----	----	03
BML801	Biomedical Microsystems	----	02	----	----	01	----	01
BML802	Hospital Management	----	02	----	----	01	----	01
BMDLL804X	Department Level Optional Course Laboratory – IV	----	02	----	----	01	----	01
BML803	Project Stage II	----	12	----	----	06	----	06
Total		**15**	**18**	----	**15**	**09**	----	**24**

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC801	Biomedical Microsystems	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC802	Hospital Management	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 801X	Department Level Optional Course - IV	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO202X	Institute Level Optional Course –II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML801	Biomedical Microsystems	---	---	---	---	25	10	---	---	25	10	---	---	50
BML802	Hospital Management	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 801X	Department Level Optional Course Laboratory – IV	---	----	---	---	25	10	---	---	25	10	---	---	25
BML803	Project Stage II	---	---	---	---	50	20	---	---	---	---	50	20	100
Total		**320**	**128**	**80**	**32**	**125**	**50**	**---**	**---**	**75**	**30**	**50**	**20**	**625**

Course Code	Department level Optional Course – III
BMDLO7031	Networking and Information in Medical System
BMDLO7032	Advanced Image Processing
BMDLO7033	Embedded Systems

Course Code	Department level Optional Course – IV
BMDLO8041	Health Care Informatics
BMDLO8042	Robotics in Medicine
BMDLO8043	Nuclear Medicine

Course Code	Institute level Optional Course – I
ILO1011	Product Lifecycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management and Mitigation Measures
ILO1018	Energy Audit and Management

Course Code	Institute level Optional Course - II
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC801	Biomedical Microsystems (Abbreviated as BM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC801	Biomedical Micro-systems (BM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC801	Biomedical Microsystems	04
Course Objectives	• To understand various fabrication techniques for MEMS devices. • To apply the knowledge of MEMS in Biomedical field. • To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.	
Course Outcomes	**Learner will be able to…** • Understand basic property and select appropriate material for MEMS application • Develop or modify the MEMS processes for a simple MEMS device in order to reduce the fabrication time. • Understand different microfabrication techniques and choose appropriate technique • Analyze Micro total analysis system with designing of its components • Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication • Understand packaging techniques used in MEMS	

Module	Contents	Hours
1	**Introduction to miniaturization and materials** • Block diagram of MEMS and BIOMEMS, comparison, examples • Clean room: definition, classification, air flow system • Safety in handling hazardous materials in clean room • Scaling Laws in Miniaturization • Substrates and Wafers: CZ process, wafer types • Materials: Properties and applications of single crystal silicon, SiO2, Si3N4, SiC, Polysilicon, GaAs, Glass, Al, Gold, PMMA, PDMS, SU8, Conducting polymers	**08**
2	**MEMS FABRICATION PROCESSES** • Wafer cleaning processes: RCA, Piranha • PVD: definition, Types: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), applicable materials, advantages, disadvantages • CVD: definition, reaction steps, types: APCVD, LPCVD, PECVD, and HWCVD, applicable materials, advantages, disadvantages • Oxidation: Thermal • Polymers coating techniques: spinning, spraying and electrodeposition • Doping: definition, Types: Ion implantation and Diffusion, advantages, disadvantages • Etching: Types: Dry etching (RIE, DRIE) and wet etching (isotropic and anisotropic), advantages, disadvantages, specific etchants • Photolithography: Definition, steps, light sources (UV, DUV, and EUV), positive and negative photoresist, mask, different projection systems • X-ray lithography: Synchrotron radiation, X-ray mask • Nanolithography: EBL • Surface characterization techniques: AFM, SEM, TEM, Ellipsometer, Profilometer	**12**
3	**Microfabrication Techniques** • Bulk micromachining: definition, advantages and disadvantages Examples: pressure sensor, dissolved wafer process, CO_2 sensor • Surface micromachining: definition, advantages and disadvantages Examples: pressure sensor, cantilever Non polysilicon surface micromachining: SOI fabrication • LIGA: definition, process steps, examples, advantages and disadvantages, Molding techniques: Injection, compression, hot embossing • Soft lithography: Definition, SAMs, Types: Micro contact Printing, • Micro molding techniques: replica molding, microtransfer molding, micromolding in capillaries and solvent-assisted micromolding	**04**
4	**MICRO TOTAL ANALYSIS SYSTEMS (μTAS)** • Basic block diagram	**08**

	• Flow techniques in µ-fluidics: pressure driven force, electro-osmosis, electrophoresis • Micropump, microvalves: types and fabrication • Microchannels: Types and fabrication (SU8, glass, silicon) • Separation techniques: capillary electropherosis, electrochromatography, isoelectric focusing Detection techniques: fluorescence, chemiluminiscence	
5	**MICRO/ NANO BIOSENSORS AND DRUG DELIVERY DEVICES** • Biosensor: definition, block diagram • Classification based on the basis of detection techniques: Electric, Magnetic, Optical, Thermal, Mechanical, and Chemical • Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer • Design, fabrication of cantilever for antibody detection • Hypodermic needles, transdermal patches : disadvantages • Micro needles: solid, hollow, polymer, silicon (fabrication) Nano particles for drug delivery	**10**
6	**MICROSYSTEM PACKAGING** • Packaging materials • Levels of packaging • Comparison between IC and MEMS packaging • Packaging technologies: Die preparation, surface bonding, wire bonding, sealing • Pressure sensor packaging	**06**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. "MEMS & MICROSYSTEMS Design and Manufacture", Tai-Ran Hsu, TATA Mcgraw-HILL.
2. "Fundamentals of Microfabrication" Marc Madou, CRC Press.

Reference Books:

1. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
2. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4
3. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
4. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0

5. “Introduction to Microfabrication”, Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
6. “Microelectromechanical Systems”, Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
7. “BIOMEDICAL NANOTECHNOLOGY”, Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC802	Hospital Management (Abbreviated as HM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC802	Hospital Manage-ment (HM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC802	Hospital Management	04
Course Objectives	• To understand the basic principles used for designing of various departments in the hospital. • To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve Hospitals. • Apply modern engineering and management principles to provide high quality of hospital care tin the community.	
Course Outcomes	**Learner will be able to** • Understand and apply resource management concepts (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors. • Understand the management structure and functions in hospital. Communicate effectively and develop their leadership and team building abilities. • Understand the principles of designing, implementing and commissioning of clinical services and supportive departments in the hospital. • Understand the roles and responsibilities of Biomedical Engineer in hospital. • Understand the functions of other Engineering services and axillary services • Understand and apply materials management concept in industry	

Module	Contents	Hours
1	**Process of management:** Principles of management, Leadership, Motivation, Time management, , H.R. management (Recruitment, Performance appraisal, Training and development,), effective communication, Accounting - Types of Budget	08
2	**Organization of the hospital & Hospital Planning:** Management structure, Types of hospitals, Governing body, Hospital committee and hospital functionaries, Duties and responsibilities of various positions. Guiding principles in planning hospital facilities and services and planning the hospital building	06
3	**Clinical and Supportive Services :** Clinical Services: **(Location, Layout , equipment** And personnel): Emergency, IN patient, OUT patient, Intensive care unit, Operation Theatre, Laboratory, Blood Bank, Radiology **Supportive services:** Registration Medical record department, Central Sterile Service Dept, Pharmacy, Laundry and Linen Medical social service Dept. Hospital security, Housekeeping, Dietary (Food services)	14
4	**Biomedical Engineering Department: (Location, Layout, equipment and personnel and functions)** Roles and responsibilities of Biomedical Engineer in hospitals, Maintenance types: Routine(preventive) and breakdown Maintenance contracts (CMC and AMC)	05
5	**Other Engineering and Auxiliary Services :** A) Engineering Services (Electrical, Mechanical and Civil) : Responsibilities and functions, Hospital Ventilation and Air Conditioning, Medical Gas systems, Communication, Hospital information systems B) Auxiliary Services: Waste management, Hospital Infection control, Disaster management	08
6	**Material Management & Inventory Control** Classification of Materials Purchase Management: Purchase system(Centralized, Decentralized, Local purchase), Purchase Procedures: Selection of Suppliers, Tendering procedures, Analyzing bids, Price negotiations, Issue of purchase orders, Rate Contracts. Store Management: Functions of Store Manager, Materials handling, Flow of goods/FIFO. Inventory Control**:** Lead-time, Buffer stock, Reorder level, Two Bin System, EOQ	07

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private Pub Bangalore)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore
3. Careers in Biomedical : Shantanu Thatte.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8041	Department Level Optional Course –IV: Healthcare Informatics (Abbreviated as HCI)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8041	Healthcare Informatics (HCI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8041	Healthcare Informatics	04
Course Objectives	• To understand the healthcare interoperability semantic and syntactic. • To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages	
Course Outcomes	**Learner will be able to** • Understand Healthcare interoperability standards • Fabricate HL7 Messages • Understand and Design UML Diagrams • Understand semantic interoperability through DICOM • Edit and Compare DICOM file	

Module	Contents	Hours
1.	**Healthcare Interoperability** Standards In Healthcare System, Categorizing Standards, Standard Development, Various Healthcare Informatics Standards, Need for a Lingua Franca, Electronic Health Records, Interoperability Modelling Basics	04

2.	**HL7 Version 2** Message Syntax, Delimiters, Segment Definition, Message Header MSH, Patient Identification Details (PID) , Patent Visit (PV1), Request and Specimen Details (OBR) , Result Details (OBX), Z-Segments, Data, Simple Data Types, Complex Data Types, Codes and Identifiers, Names and Addresses, Other Complex Data Types	**08**
3.	**Unified Modelling Language (UML):** Use Case Diagrams, Activity Diagrams, Class Diagrams, Sequence Diagrams **HL7 Version 3:** Main goal of V3, V3 Development Methodology, V3 Messaging Components, Artifacts of the V3 Design Methodology, Dynamic Models, Static Models Clinical Document Architecture: Data Types, Codes and Vocabularies, Header , Body	**12**
4.	**DICOM standard:** Introduction, DICOM Grammar: VRs, DICOM Data Dictionary, DICOM Objects, DICOM Information Hierarchy, Modules, IODs and IEs	**06.**
5.	**DICOM Communications:** DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move, DICOM: Ping, Push and Pull	**08.**
6.	**DICOM Associations** Association Establishment, Transfer Syntax, Application Context, **DICOM Media: Files, Folders, and DICOMDIRs** DICOM File Format, DICOM File Services, Storing DICOM Data in PACS	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
2. Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication
   CDA™ Book, By Keith Boone, Springer Publication

Reference Books:

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer CRC Press

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8042	Department Level Optional Course –IV: Robotics in Medicine (Abbreviated as RIM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8042	Robotics in Medicine (RIM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8042	Robotics in Medicine	04
Course Objectives	• To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. • To introduce to various applications of Robots in Medicine.	
Course Outcomes	**A Learner will be able to** • Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. • Design Robotic systems for Medical application.	

Module	Contents	Hours
1.	Introduction Automation and Robots, Classification, Application, Specification, Notations	06
2.	Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	08

3.	Inverse Kinematics General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	**10**
4.	Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	**10**
5.	Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.	**08**
6.	Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	**06**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text books:
1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:
1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8043	Department Level Optional Course –IV: Nuclear Medicine (Abbreviated as NM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8043	Nuclear Medicine (NM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8043	Nuclear Medicine	04
Course Objectives	• To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. • To keep the students abreast with the technological developments in the field of nuclear medicine.	
Course Outcomes	**Learners will be able to** • Understand essential physics of nuclear medicine such as basic concepts of radioactivity, its measurement, interaction with matter and radionuclide production. • Understand concepts of radiopharmaceuticals and various aspects of radiation safety. • Apply the principles of physics to understand working of various detectors and counting systems. • Study principle of operation of different scanning system and their quality control function. • Understand various Emission Tomography Techniques along with their Clinical Applications. • Understand concept of radionuclide therapy and the function of	

	radiotherapy equipment.

Module	Content	Hours
1.	**Basics of Nuclear Physics**: Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Decay scheme of Mo-99. Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter **Production of Radionuclide:** Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron & Radionuclide Generators Spectra of commonly used radio nuclides e.g Tc-99m, Cs-137. Problems in radiation measurements.	**10**
2.	**Radiopharmaceuticals:** Ideal Radiopharmaceutical, Methods of Radiolabeling **Internal Radiation Dosimetry:** Absorbed Dose Calculations to Target & Non-Target Tissues, MIRD Methodology **Radiation Safety:** Natural & Artificial Radiation Exposure, External & Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External & Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management.	**08**
3.	**Detectors in Nuclear Medicine & Counting and Measuring System:** Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors. **In Vitro techniques(Brief Description):** Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA Applications.	**10**
4.	**In Vivo Techniques:** General Principle, Uptake Monitoring System, Rectilinear Scanner, Gamma Camera Fundamentals, Position Circuitry and working, Computer Interface, Performance Parameters, Quality Control Functions	**07**
5.	**Emission Tomography Techniques and Clinical Applications**: Introduction, Principles and applications of SPECT, Principles and applications of PET, System performance parameters and Quality Control Functions. **Introduction to Hybrid Modalities:** PET/CT, SPECT/CT **Clinical Applications** Clinical Applications of PET, SPECT and Hybrid Modalities in Cardiology, Neurology and Oncology.	**08**
6.	**Radionuclide Therapy** Choice of a Radionuclide in Therapeutic Nuclear Medicine Treatment of Benign & Malignant Diseases Palliative & Curative Procedures Radiotherapy Equipment: Cobalt unit, Gamma knife	**05**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea& Febiger.
2. B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science+Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea& Febiger.

References Books:

1. William R. Hendee, *Medical Radiation Physics*, Year Book Medical Publishers
2. G. Hine, *Instrumentation of Nuclear medicine*, Academic Press
3. Glenn F. Knoll, *Radiation Detection & Measurement*, John Wiley & Sons.

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2021	Institute Level Optional Course –II: Project Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2021	Institute Level Optional Course – II Project Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2021	Project Management	03
Course Objectives	• To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. • To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.	
Course Outcomes	**Learner will be able to** • Apply selection criteria and select an appropriate project from different options. • Write work break down structure for a project and develop a schedule based on it. • Identify opportunities and threats to the project and decide an approach to deal with them strategically. • Use Earned value technique and determine & predict status of the project. • Capture lessons learned during project phases and document them for future reference	

Module	Detailed Contents	Hours
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	05
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	06
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	08
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	06
05	**Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	08
06	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration,	06

	Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2022	Institute Level Optional Course –II: Finance Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2022	Institute Level Optional Course – II Finance Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2022	Finance Management	03
Course Objectives	• Overview of Indian financial system, instruments and market • Basic concepts of value of money, returns and risks, corporate finance, working capital and its management • Knowledge about sources of finance, capital structure, dividend policy	
Course Outcomes	**Learner will be able to** • Understand Indian finance system and corporate finance • Take investment, finance as well as dividend decisions	

Module	Detailed Contents	Hours
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity	06

	Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market. **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	**06**
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	**09**
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2023	Institute Level Optional Course –II: Entrepreneurship development and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2023	Institute Level Optional Course – II Entrepreneurship Development and Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2023	Enterpreneurship Development and Management	03
Course Objectives	• To acquaint with entrepreneurship and management of business • Understand Indian environment for entrepreneurship • Idea of EDP, MSME	
Course Outcomes	**Learner will be able to** • Understand the concept of business plan and ownerships • Interpret key regulations and legal aspects of entrepreneurship in India • Understand government policies for entrepreneurs	

Module	Detailed Contents	Hours
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of	04

	Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	**09**
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	**05**
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	**08**
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	**08**
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	**05**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2024	Institute Level Optional Course –II: Human Resource Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2024	Institute Level Optional Course – II Human Resource Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03
Course Objectives	• To introduce the students with basic concepts, techniques and practices of the human resource management. • To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective. • To familiarize the students about the latest developments, trends & different aspects of HRM. • To acquaint the student with the importance of behavioral skills, Inter-personal, inter- group in an organizational setting. • To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource management.	
Course Outcomes	**Learner will be able to** • Gain knowledge and understand the concepts about the different aspects of the human resource management.	

	• Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture. • Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment. • Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.

Module	Detailed Contents	Hours
01	**Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	**05**
02	**Organizational Behavior (OB) :** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	**07**
03	**Organizational Structure & Design:** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**06**
04	**Human resource Planning:** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training	**05**

	Methods	
05	**Emerging Trends in HR :** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	**06**
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	**10**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2025	Institute Level Optional Course –II: Professional Ethics and Corporate Social Responsibility	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2025	Institute Level Optional Course – II Professional ethics and Corporate Social Responsibility	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2025	Professional Ethics and Corporate Social Resonsibility (CSR)	03
Course Objectives	• To understand professional ethics in business • To recognized corporate social responsibility	
Course Outcomes	Learner will be able to • Understand rights and duties of business • Distinguish different aspects of corporate social responsibility • Demonstrate professional ethics • Understand legal aspects of corporate social responsibility	

Module	Detailed Contents	Hours
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	**04**
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	**08**
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	**06**
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	**05**
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	**08**
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	**08**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.

Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2026	Institute Level Optional Course –II: Research Methodology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2026	Institute Level Optional Course – II Research Methodology	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2026	Research Methodology	03
Course Objectives	• To understand Research and Research Process • To acquaint students with identifying problems for research and develop research strategies • To familiarize students with the techniques of data collection, analysis of data and interpretation	
Course Outcomes	**Learner will be able to** • Prepare a preliminary research design for projects in their Course matter areas • Accurately collect, analyze and report data • Present complex data or situations clearly • Review and analyze research findings	

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**10**
02	**Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	**08**
03	**Research Design and Sample Design :** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**08**
04	**Research Methodology :** Meaning of Research Methodology, Stages in Scientific Research Process **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research:** Preparation of the report on conclusion reached,	**04**

	Validity Testing & Ethical Issues, Suggestions and Recommendation	

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2027	Institute Level Optional Course –II: IPR and Patenting	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2027	Institute Level Optional Course – II IPR and Patenting	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03
Course Objectives	• To understand intellectual property rights protection system • To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures • To get acquaintance with Patent search and patent filing procedure and applications	
Course Outcomes	**Learner will be able to** • understand Intellectual Property assets • assist individuals and organizations in capacity building • work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting	

Module	Detailed Contents	Hours
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	**05**
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	**07**
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	**06**
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	**07**
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	**08**
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	**07**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield,2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar andmohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005,Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2028	Institute Level Optional Course –II: Digital Business Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2028	Institute Level Optional Course – II Digital Business Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2028	Digital Business Management	03
Course Objectives	• To familiarize with digital business concept • To acquaint with E-commerce • To give insights into E-business and its strategies	
Course Outcomes	**The learner will be able to** • Identify drivers of digital business • Illustrate various approaches and techniques for E-business and management • Prepare E-business plan	

Module	Detailed content	Hours
1	**Introduction to Digital Business:** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09

2	**Overview of E-Commerce: E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	**06**
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, **Application Development:** Building Digital business Applications and Infrastructure	**06**
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e-business - Security Overview, Electronic Commerce Threats, Encryption, ryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	**06**
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	**04**
6	**M Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	**08**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2029	Institute Level Optional Course –II: Environmental Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2029	Institute Level Optional Course – II Environmental Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2029	Environmental Management	03
Course Objectives	• Understand and identify environmental issues relevant to India and global concerns • Learn concepts of ecology • Familiarise environment related legislations	
Course Outcomes	**Learner will be able to** • Understand the concept of environmental management • Understand ecosystem and interdependence, food chain etc. • Understand and interpret environment related legislations	

Module	Detailed Contents	Hours
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy	10

	scenario.	
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	**06**
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	**05**
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	**10**
05	Total Quality Environmental Management, ISO-14000, EMS certification.	**05**
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	**03**

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML803	Project Stage - II	--	12	--	--	06	--	06

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML 803	Project Stage - II	--	--	--	--	50	--	--	100	150

Course Code	Course Name	Credits
BML803	Project Stage-II	06
Course objective	• Implement the concept of Project Stage-I • Use advanced tools for Implementation • Rectify/ Debug the design and Submit project report.	
Course Outcome	**Learner will be able to** • Debug/ Rectify the design incurred during implementation • Write Analysis, Results, Design in prescribed format • Learn the behavioral science by working in a group	

Pr**oject Guidelines:**

1. The students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I and should attempt solution to the problem.
2. Learner is allotted 12 hrs per week for the project work
3. Report should be prepared as per the guidelines issued by the University of Mumbai
4. Learners should be motivated to publish a paper based on the work in Conferences/students competitions
5. Project Groups: Learners can form groups not more than 4 (Four)

Faculty Load:

1. In semester VIII - 1 (One) periods of 1 hour each per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Assessment:

Term Work:

The Term Work should be examined by approved internal faculty appointed by the head of the institute based on following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

Guidelines for Assessment of Project Stage- II

1. Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
2. Project stage II should be assessed based on following points
    - Quality of problem selected
    - Clarity of Problem definition and Feasibility of problem solution
    - Relevance to the specialization / Industrial trends
    - Clarity of objective and scope
    - Quality of work attempted
    - Validation of results
    - Compilation of Project Report
    - Quality of Written and Oral Presentation

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML801	Biomedical Microsystems (BM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML801	Biomedical Microsystems (BM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML801	Biomedical Microsystems	01
Course Objectives	• To understand various fabrication techniques for MEMS devices and applying them for fabricating biomedical devices.	
Course Outcomes	**Learner will be able to…** • Select appropriate material, fabrication technique and packaging technique for given application • Simulate given microsystems to evaluate its performance	

Syllabus: Same as that of BMC801 Biomedical Microsystems(BM).

List of Experiments: (Any Three)

1. Simulation of scaling law
2. Crystal structure
3. Biosensors
4. Simulation of pressure sensors
5. Simulation of cantilever
6. Simulation of Microchannel
7. Simulation of Microvalve

8. Simulation of Micropump

List of Tutorials (Any Four)

1. Scaling Laws
2. Materials for MEMS
3. MEMS deposition techniques
4. MEMS etching techniques
5. Lithography
6. Surface characterization techniques
7. Micromachining
8. Softlithography
9. Micro Total Analysis systems
10. Drug delivery devices
11. MEMS packaging

Any other experiment based on syllabus which will help learner to understand topic/concept.

Presentation based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 3 experiments and 4 Tutorials.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments and Tutorials) : 10 Marks
Presentation : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. "MEMS & MICROSYSTEMS Design and Manufacture", Tai-Ran Hsu, TATA Mcgraw-HILL.
2. "Fundamentals of Microfabrication" Marc Madou, CRC Press.

Reference Books:

1. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
2. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4
3. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
4. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS,

eBook ISBN: 0-306-47601-0
5. "Introduction to Microfabrication", Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
6. "Microelectromechanical Systems", Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
7. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML802	Hospital Management (HM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML802	Hospital Management (HM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML802	Hospital Management	01
Course Objectives	• To understand the basic principles used for designing of various departments in the hospital. • To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve Hospitals. • Apply modern engineering and management principles to provide high quality of hospital care tin the community.	
Course Outcomes	**Learner will be able to** • Understand and apply finance management concepts and the processes and strategies needed in specific hospital sectors. • Understand the management structure and functions in hospital. Communicate effectively and develop their leadership and team building abilities. • Design the layout of clinical services and supportive departments in	

	the hospital. • Understand the roles and responsibilities of Biomedical Engineer in hospital. • Understand the functions of other Engineering services and axillary services • Understand and apply materials management and the purchase procedure in industry

Syllabus: Same as that of BMC802 Hospital Management (HM).

List of Experiments and Assignments: (Any Four Experiments and Any Four Assignments)

1. Design of Registration form of hospital.
2. Prepare budget using EXCEL sheet for purchase of hospital equipment.
3. Preparation of Comparative Statement of Equipment for purchase **(Any Two)**
4. Negotiations of the equipment in the comparative statement.
5. Design the layout of Out Patient Department in hospital.
6. Design the layout of In Patient Department in hospital.
7. Design the layout of Surgical Operation Theatre Complex in hospital.
8. Design the layout of Radiology Department in hospital.
9. Design the layout of Pathology Laboratory and Blood Bank Department in hospital.
10. Design the layout of Physiotherapy Department in hospital.
11. Design the layout of Central Sterile Supply Department in hospital.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentation based on the assigned topic by visiting a hospital.

Assessment:

Term Work:

Term work shall consist of minimum 4 experiments, 4 assignments and presentation.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Assignments) : 05 Marks
Presentations : 05 Marks
Attendance : 05 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private Pub Bangalore)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore
3. Careers in Biomedical : Shantanu Thatte.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 8041	Healthcare Informatics (HCI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 8041	Healthcare Informatics (HCI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL8041	Healthcare Informatics	01
Course Objectives	• To understand the healthcare interoperability semantic and syntactic. • To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages	
Course Outcomes	**Learner will be able to** • Fabricate HL7 Messages • Edit and Compare DICOM file	

Syllabus: Same as that of BMDLO8041 Healthcare Informatics (HCI).

List of Experiments: (Any Seven)

1. To find term/ Concept and ID or Vocabulary codes

2. Identifying and Chapters of Health Level 7 for trigger Event and message types and message
3. Structure should be sent to cover each requirement
4. Reading and editing segment
5. Create Health Level 7 Message
6. Create Patient Information Database from Health Level 7 Messages
7. To Study DICOM Validation Tool (DVTK)
8. Edit DICOM File using hex-Editor\
9. Creating Database of a patient
10. Comparing DICOM file

Any other experiment based on syllabus which will help learner to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
2. Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication
   CDA™ Book, By Keith Boone, Springer Publication

Reference Books:

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer CRC Press

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 8042	Robotics in Medicine (RIM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 8042	Robotics in Medicine (RIM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL8042	Robotics in Medicine	01
Course Objectives	• To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. • To introduce to various applications of Robots in Medicine.	
Course Outcomes	**A Learner will be able to** • Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. • Design Robotic systems for Medical application.	

Syllabus: Same as that of BMDLO8042 Robotics in Medicine (RIM).

List of Tutorials: (Any Seven)

1. Automation and Robots Classification
2. Specification, Notations
3. Direct Kinematics Dot and cross products
4. Five- axis robot, Four-axis robot, Six-axis robot(Direct Kinematics)
5. Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics)
6. Robot Vision Image representation
7. Segmentation
8. Applications in Biomedical Engineering ,Application in rehabilitation, Clinical and Surgery

9. Task Planning, Task level programming

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus. Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:

1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Course Code	Course Name	Teaching scheme			Credit assigned			
BMDLL	**Nuclear**	**Theory**	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**

8043	**Medicine (NM)**	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Course Code	**Course Name**	**Examination Scheme**								
		Theory				**Term work**	**Pract.**	**Oral**	**Pract. / Oral**	**Total**
		Internal Assessment			**End sem**					
		Test 1	**Test 2**	**Avg.**						
BMDLL 8043	**Nuclear Medicine (NM)**	**--**	**--**	**--**	**--**	**25**	**--**	**25**	**--**	**50**

Course Code	**Course Name**	**Credits**
BMDLL8043	**Nuclear Medicine**	**01**
Course Objectives	• To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. • To keep the students abreast with the technological developments in the field of nuclear medicine.	
Course Outcomes	**Learners will be able to** • Understand essential physics of nuclear medicine such as basic concepts of radioactivity, its measurement, interaction with matter and radionuclide production. • Understand concepts of radiopharmaceuticals and various aspects of radiation safety. • Apply the principles of physics to understand working of various detectors and counting systems. • Study principle of operation of different scanning system and their quality control function. • Understand various Emission Tomography Techniques along with their Clinical Applications. • Understand concept of radionuclide therapy and the function of radiotherapy equipment.	

Syllabus: Same as that of BMDLL8043 Nuclear Medicine (NM).

List of Experiments and Tutorials: (Any Seven)

1. Interaction of Radiations with Matter

2. Classification of Detectors
3. Gas Filled Detectors
4. Scintillation and Solid State Detectors
5. Gamma Camera
6. Liquid Scintillation Technique
7. Tracers in Uptake Studies
8. Uptake Studies
9. Radiation Safety

Industry / Hospital Visits may be conducted.

Any other experiment and tutorials based on syllabus which will help learner to understand topic/concept.

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments and Tutorials) : 10 Marks
Presentation : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea& Febiger.
2. B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science+Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea& Febiger.

References Books:

1. William R. Hendee, *Medical Radiation Physics*, Year Book Medical Publishers
2. G. Hine, *Instrumentation of Nuclear medicine*, Academic Press
3. Glenn F. Knoll, *Radiation Detection & Measurement*, John Wiley & Sons.

UNIVERSITY OF MUMBAI
No. UG/ 181 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the Master of Management Studies (MMS) degree programme **vide** this office Circular No. UG/27 of 2014 dated 8th August, 2014 and the Directors, of all University Institution and the Directors of all recognized Institutions of Management Studies are hereby informed that the proposal received from the Co-ordinator, Faculty of Management, approved by the Academic Council at its meeting held on 14th July, 2016 **vide** item No. 4.91 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Management Studies (MMS) (Sem. I & II), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

21/11/16

MUMBAI – 400 032
22 November, 2016

(Dr.M.A. Khan)
REGISTRAR

To,

The Directors, of all University Institution and the Directors of all recognized Institutions of Management Studies.

A.C/4.91 /14/07/2016

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No. UG/ 181 -A of 2016-17 MUMBAI-400 032 22 November, 2016

Copy forwarded with compliments for information to:-

1) The Co-ordinator, Faculty of Management,
2) The Director, Board of College and University Development,
3) The Controller of Examinations,
4) The Professor-cum- Director, Institute of Distance and Open Learning (IDOL),
5) The Co-Ordinator, University Computerization Centre.

21/11/16

(Dr.M.A. Khan)
REGISTRAR

PTO..

UNIVERSITY OF MUMBAI

Restructured & Revised Syllabus under

Credit based Semester and Grading System

for

Master of Management Studies (MMS)
Semester I & II

2 Years full-time Masters Degree Course
in Management

(Effective from the academic year 2016 – 2017)

Title

Name of the Programme: - MASTER OF MANAGEMENT STUDIES (MMS)

Nature of the Programme: - MMS (Master of Management Studies) is a 2 year Full time Master's Degree course of University of Mumbai.

Eligibility Criteria

as per the directives of Directorate of Technical Education, Government of Maharashtra

Preamble

We see a kind of Education inflation in India. This means that a particular qualification which served a purpose at one time or is supposed to fulfill is no longer perceived to be enough in today's times. It requires an additional degree or certification to become truly employable. Hence, it becomes important to bring relevance and constant innovation in curriculum, pedagogy, emphasis on 'learning by doing' so as to make students future ready and employable. MMS kind of programmes have to take into account this reality. It needs to metamorphose into an Application oriented programme.

Secondly, let us refer to a section of young people and particularly those who have reached at the higher education level. They have access to much more information than their previous generations. Free content through the internet, open source knowledge, new media platforms has led to higher level of exposure for the youth. Hence the MMS classroom can no longer be a place just for knowledge dissemination. It needs to help the youth to go into the depth of matters, make meaning out of available information, learn problem solving in whichever domains they are inclined to and yet be holistic in their thinking due to the interconnections and interdependencies in the world. One must also be mindful that independent decision making must be encouraged for students at the Post graduate level. This means that students at this stage must chart their professional career while being lifelong learners. This process begins during the programme itself and hence the MMS now needs to offer a plethora of optional subjects which are chosen by the students as per their own abilities and aspirations. This will help them to sharpen their focus early on.

Thirdly, in India low cost innovation, offerings for different demographics, emerging markets in rural / tier 2 or 3 towns / urban lower classes are changing the business landscape. Management education has to gear up to nurture people to create new opportunities in this situation.

Another point of relevance is that professional management is now required in other arenas too like social entrepreneurship, public governance and in running voluntary organisations. This renders the scope of the MMS to be more broad-based now.

Along with employability, entrepreneurship must be a thrust area for management graduates. The MMS programme must thus prepare potential entrepreneurs to base their ventures on solid offerings for sustained greatness. They also need to be warned and shielded from the temptations of riding on a perceived wave.

The future of management and business can be sustained only if business is carried out in an ethical and responsible way. Sustainable development is no longer a choice but the only way of taking mankind forward. Sustainable development is not an isolated subject. It needs to be the underlying theme in every domain and practice.

Disciplines are merging in the new economy. Changing values, beliefs, attitudes are causing a new social order. All this impacts industry and redefines industry. The MMS programme needs to help people to navigate through this reality.

The restructured and revised curriculum for MMS is developed considering the current industry needs in terms of skill sets demanded under new business environment. It also endeavours to align the programme structure and course curriculum with student aspirations and corporate expectations.

Need for Revision and Restructure of MMS Curriculum

Revision is a learning process. As Donald Norman points out in Things That Make Us Smart, Human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits. The real powers come from devising external aids that enhance cognitive abilities. To serve our students with developmental needs, a review of the developmental curriculum and institutional structure were needed in order to determine whether the developmental areas reflect recognized best practices. The developmental areas are defined as courses or services provided for the purpose of helping underprepared college students attain their academic goals.

The Current Scenario

1. Changing global facets of businesses and economies
2. Dynamism in industry practices and evolution of technology
3. Emergence of new businesses and business practices
4. Thrust on Application oriented and experiential learning
5. Expectations of Key stakeholders viz. Students, Industry and Academicians

This has led to

Gaps in Current Curriculum

1. Lack of specialized in – depth knowledge in a specific domain.
2. Lack of thrust on current management practices.
3. Absence of cross-functional skills and holistic thinking.
4. The challenge is to become a place, where leadership is promoted and nurtured with a long-term vision.
5. B-schools must be creative and introduce innovative courses for the overall development of the students.

Objectives for New Curriculum

The MMS programme prepares a student for a career in diverse sectors nationally as well as globally. The MMS programme facilitates absorption & application of knowledge in theory and practice across multiple functional areas of management and enables students to adopt an integrated approach towards real life situations and circumstances.

The Objectives of New Curriculum are

1. To thrive in complex reality and to acquire a systemic understanding of what organizations are, how they work and how they can interact effectively with their commercial, social and physical environment
2. To nurture and develop higher consciousness, cognitive flexibility by developing a strong base to build professional career and to channel that knowledge into a targeted career direction
3. To Change mindset of the Learner and to develop well trained leaders and managers who are responsible citizens.
4. Incorporate some flexibility for institutes to teach new and contemporary curriculum for greater employability of their students.
5. Make the course attractive for large number of students to specialize in the existing domains and other attractive new domains like education management, corporate law and consultancy streams.
6. Institutions should also inculcate multitasking abilities amongst students, learning foreign languages and advanced IT knowledge so that they can perform better in the chosen field nationally and internationally
7. Providing more flexibility to individual Institutes for introducing courses/electives.

The goal is aimed at to imbibe and enhance the following skill sets

1. Exposure to Global practices
2. Application of technology and enhancement of technological skills
3. Peer based learning and team work
4. Experiential Learning (Learning by Action and Application)
5. Team building basics and its orientation

With the breadth and depth of our **core** and **electives**, students can take a multi-disciplinary approach or delve deeply into a single area.

Highlights of the New Curriculum

1) additional choices in electives from 1st semester
2) Providing the much needed flexibility to individual Institutes to carve a niche for themselves
3) Reduction in the number of subjects in all semesters to enable students to delve deep into the domain specialization subjects and utilize the time for employment oriented training for their employability.
4) Commencement of Specializations from 3rd Semester.
5) Augmentation in the number of electives starting from 2nd semester to provide greater flexibility and choice from the career perspective.

Structure of the Revised MMS Curriculum

The courses under the revised structure and curriculum fall under two categories of **Core** (common for all specializations), and **Electives** (choice for students within specializations) leading towards super specialization. The electives component will provide flexibility and allow the institutes to provide some initiatives in new courses, coaching and mentoring process to nurture professional competencies. List of elective courses allows flexibility for institutes to teach courses keeping in mind industry needs and student's profile so as to enable them to position themselves based on their areas of expertise.

The essence of this structure is to encourage students to "**think like a mountain"**, starting with a broad canvas to assimilate knowledge from all facets of management and meticulously move towards acquisition and practice of excellence in a specific and desired domain of expertise.

Learning Pedagogy

1. Foundation Course is the cornerstone of the MMS program. It is offered before the commencement of MMS programme to acquaint with the basics of the course.
2. The first semester is the foothill, where the odyssey begins. A common base of knowledge essential for all management professionals. The first semester shall be consisting of 8 subjects - 5 (five) core and 3 (three) elective from the bunch of 10 subjects.
3) Having cleared the foothills, students in the second semester endeavour to attain further skill sets through an integrated frame work, which guides them towards their desired field through subtle introduction of relevant subjects. The second semester would consist of eight subjects of which 5 subjects would be core subjects and 3 subjects would be electives from the bunch of 10 subjects.

Teaching Pedagogy

Teachers are expected to impart knowledge along-with traditional teaching through new and innovative pedagogical approaches.

Some of these techniques are: -

Reading, Group Discussions, Lectures, Role plays, Field Work, Workshops, Counseling Sessions, Watching Educational and Informative Videos, Assignments, Quizzes, Tests, Live Projects, Case Studies, Presentations, Simulations, Industrial Visits, Participation in academic and extra – curricular activities, inculcation of industry specific skills and training & development sessions.

UNIVERSITY OF MUMBAI , MUMBAI

Masters in Management Studies - Semester I (CBGS)

with effect from Academic Year 2016-17

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper	No of Credits
1	Perspective Management	27	2	40 IA	60 IA	100	3hr	4
2	Financial Accounting	27	2	40 IA	60 IA	100	3hr	4
3	Business Statistics	27	2	40 IA	60 IA	100	3hr	4
4	Operations Management	27	2	40 IA	60 IA	100	3hr	4
5	Managerial Economics	27	2	40 IA	60 IA	100	3hr	4

3 ELECTIVES OUT OF 10								
1	Effective and Management Communication	27	2	40 IA	60 IA	100	3hr	4
2	Business Ethics	27	2	40 IA	60 IA	100	3hr	4
3	Ecommerce	27	2	40 IA	60 IA	100	3hr	4
4	Organizational Behaviour	27	2	40 IA	60 IA	100	3hr	4
5	Introduction to Creativity and Innovation Management	27	2	40 IA	60 IA	100	3hr	4
6	Foreign Language (Other than English)	27	2	40 IA	60 IA	100	3hr	4
7	Negotiation and Selling Skills	27	2	40 IA	60 IA	100	3hr	4
8	IT Skills for Management and Technology Platform	27	2	40 IA	60 IA	100	3hr	4
9	Information Technology for Management	27	2	40 IA	60 IA	100	3hr	4
10	Personal Grooming / Personal Effectiveness	27	2	40 IA	60 IA	100	3hr	4
							Total No of Credits	**32**

UA: University Assessment **IA: Internal Assessment**

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester I

Sr. No.	Core	Sr. No.	Electives (Any 3)
1	Perspective Management	1	Effective and Management Communication
2	Financial Accounting	2	Business Ethics
3	Business Statistics	3	Ecommerce
4	Operations Management	4	Organizational Behaviour
5	Managerial Economics	5	Introduction to Creativity and Innovation Management
		6	Foreign Language (Other than English)
		7	Negotiation and Selling Skills
		8	IT Skills for Management and Technology Platform
		9	Information Technology for Management
		10	Personal Grooming / Personal Effectiveness

Note:

1 All subjects / papers for Semester I will be internally assessed by the institute. The Criteria for the same is given below

a) Attendance and Class Room Participation 10 Marks

b) Minimum 3 criteria to be picked up from the below given list

- Mid term Test (Min 1)
- Group Presentations
- Role Plays
- Case Studies
- Assignments
- Projects
- Quizes

2 Institute will have the discretion to select minimum 3 (three) subjects or more from given list of 10 subjects. Total 32 credits has to be obtained.

3 Any new elective proposed to be introduced by the Institute, apart from electives listed in the new syllabus, need to take prior approval from Board of Management Studies of the University in writing outlining the details of the course with learning objectives, learning outcomes, detailed syllabus, teaching learning plan and course evaluation procedures atelast 6 months in advance before the commencement of the semester.

PROGRAM : MMS

Semester	**:**	**I - Core**			
Title of the Subject / course	**:**	**Perspective Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To explain the relationships between organizational mission, goals, and objectives
2	To comprehend the significance and necessity of managing stakeholders
3	To conceptualize how internal and external environment shape organizations and their responses
4	To develop critical thinking skills in identifying ethical, global, and diversity issues in planning, organizing, controlling and leading functions of management
5	To Understand organizational design and structural issues
6	To understand that citizenship involves taking conscious steps for societal advancement at individual level and organizational level

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Fundamentals for personal and organisational success Fundamentals of personal leadership	Lecture, interaction, discussion.Examining success stories through videos of industry pioneers followed by discussion	The student will be able to look at multiple perspectives that impact business and life.
2	Management: Science, Theory and Practice – The Evolution of Management Functions of Management Nature and purpose of Planning Objectives, Strategies, Policies and Planning Premises – Decision making – Global Planning	Self-study, Discussion, Quiz	To demonstrate empirical understanding of various organizational processes and behaviors and the theories associated with them
3	Managing your career and understanding organisational dynamics: - Leadership functions and corresponding skills required - Choosing the right positions	Discussion	The student will be able to demonstrate leadership behaviours which will be three pronged: leading self, leading others and leading for change and impact.

Sr. No.	Content	Activity	Learning outcomes
	- Special dilemmas of early career - Landing stretch assignments - Building a network of relationships - Challenges faced by the minority - Developing ethical judgment - Assessing your career		
4	Managing in adversities / Management of crisis	Case Study	The Student will explore different approaches and their consequences during crisis management
5	Social Responsibility, Ethics and Sustainable Development	Discussion, Case study, Group work, Movie, Student Presentation, Debate on MBA Oath	To understand the role of managers and citizens in society
6	Mind control and spiritual Quotient	Literature Reading, Discussion	The Student will learn ways of staying positive and having a healthy mind
7	Role and Responsibilities of a Manager, Effective and Ineffective Managerial styles	Caselets, role plays and discussions	To understand the roles and functions of managers at various (entry, middle and the top) levels
8	Difference between management and leadership, Understanding Level 5 Leadership	Literature reading and Discussion	The student will understand the behavior, skills and mindset of a manager and of a leader.
9	Strategic Management – Definition, classes of decisions, levels of decision, Strategy, Role of different Strategists, Relevance of Strategic Management and its benefits, Strategic Management in India	Discussion, Student Presentations, Case study	The Student will understand various concepts and examples related to Strategic Management
10	Change Management	Discussion, Movies, Case study	The Student will learn about the various steps to be followed to bring about change
11	Total Quality Management	Discussion, Quiz	The Student will understand the concepts and examples of TQM

Text books

1	Principles and Practices of Management by DrKiranNerkar and Dr Vilas Chopde
2	Principles of Management – Davar
3	Essentials of Management – Koontz &Weihrich
4	Strategic Management – V S P Rao& V Hari Krishna

Reference books

1	The Leader Within – DreaZigarmi, Michael O'Connor, Ken Blenchard, Carl Edeburn
2	The Action-Centred Leadership – John Adair
3	Good to Great – Jim Collins
4	Leadership – Rudolph Guliani
5	The Mind and its Control – Swami Budhananda
6	Management – a competency building approach – HeilReigel / Jackson/ Slocum

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Core**			
Title of the Subject / course	**:**	**Financial Accounting**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To understand the basic concepts and fundamentals used in financial accounting.
2	To learn all the intricacies of corporate financial statements.

Prerequisites if any	
Connections with Subjects in the current or Future courses	This subject will provide basic knowledge of accounting which will be useful and required for the subjects in the area of finance in the upcoming terms

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction to Accounting Meaning and necessity of accounting Accounting cycle An overview of Financial Statements – Income Statement and Balance Sheet	Lecture and discussion	Clarity and understanding of the basic concepts of accounting and financial statements
2	Introduction and meaning of GAAP, IFRS and Ind AS Important Accounting Standards Concepts used in accounting Concepts related to Income Statement and Balance Sheet Accounting Equation and its relation to accounting mechanics	Theoretical discussion and explanation	Ability to apply the principles and concepts of accounting in preparing the financial statements
3	Accounting mechanics and process leading to preparation of Trial Balance and Financial Statements	Theoretical discussion and exercises	Ability to execute the accounting process- Recording- Classifying and Summarizing. Understanding the use of accounting software
4	Preparation of Financial Statements with Adjustment - 'T' form and vertical form of financial statements Detailed discussion and understanding of various items in Schedule III Preparation of Corporate Financial Statements and Notes to Accounts	Theoretical discussion and problem solving	Detailed and in depth understanding of all the items in the corporate financial statements
5	Revenue recognition and measurement Capital and revenue items Treatment of R & D expenses Preproduction cost Deferred revenue expenditure etc.	Theoretical discussion and exercises	Understanding the principles of revenue recognition and ability to distinguish between revenue and capital income and expenditure and their treatment in corporate financial statements
Sr.	**Content**	**Activity**	**Learning outcomes**

No.			
6	Fixed Assets and Depreciation Accounting	Theoretical discussion and problem solving	Understanding different methods of depreciation and their impact on profitability and asset valuation
7	Evaluation and accounting of Inventory	Theoretical discussion and problem solving	Understanding the concepts of inventory valuation and their effect on profit and cost of goods sold.
8	Fund Flow Statement Cash Flow Statement	Problems and exercises with theoretical discussion	Ability to prepare a statement of changes in financial position with respect to working capital and cash flow.
9	Corporate Financial Reporting – Reading of Annual Report, Presentation and analysis of audit reports and directors report. (Students should be exposed to reading of Annual Reports of companies both detailed and summarized version)	Assignment discussion	Ability to read Annual Reports, Presentation and analysis of audit reports and directors' report
10	Basics of Cost Accounting	Theoretical discussion	Understanding basic cost concepts and ability to prepare a simple cost sheet
11	Ethical Issues in accounting	Theoretical discussion	Understanding the difference between errors and frauds; creative accounting and the Corporate Governance Report.

Text Books

1	Financial Accounting for Management – Dinesh D Harsolekar
2	Financial Accounting –Text and Cases – Dearden and Bhattacharyya
3	Accounting- Text and Cases – Robert Anthony, david Hawkins and Kenneth Merchant

Reference Books

1	Financial Accounting - Reporting & Analysis – Stice and Diamond
2	Full Text of Indian Accounting standard – Taxmann Publication
3	Financial Accounting for Managers – T.P. Ghosh
4	Financial Accounting – R. Narayanaswamy

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Core**			
Title of the Subject / course	**:**	**Business Statistics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To know statistical techniques
2	To understand different statistical tools
3	To understand importance of decision support provided by analysis techniques
4	To appreciate and apply it in business situations using caselets, modeling, cases and projects
5	To understand Managerial applications of Statistics

Prerequisites if any	Basic Mathematics
Connections with Subjects in the current or Future courses	Operations Research, Economics, Research Methodology, Quantitative Techniques, Project Management, Financial Management, production and operations management,

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Revision of Data Representation, Central Tendency and Dispersion Kurtosis and Skewness	Problem solving, cases demonstrating typical uses of mean, mode median, Use of Microsoft Excel, available software	Learner will be able to apply these basic concepts in business situations, Analyse charts graphs to analyse business situations
2	Probability- Axioms, Addition and Multiplication rule, Types of probability, Independence of events, probability tree, Bayes' Theorem	Solving problems and Caselets, Writing short cases	Understand the uncertainty in business situations as probability
3	Concept of Random variable, Probability distribution, Expected value and variance of random variable, conditional expectation, Classical News Paper boys problem(EMV, EVPI)	Problem solving , Creating decision tree, cases	Understand decision under risk, use of conditional expectation as basis for comparison
4	Probability distributions Binomial, Poisson, Normal	Problem solving, Microsoft excel, cases	Use of distributions in Quality control, Six sigma and process control
5	Sampling distribution	Problem solving, Microsoft excel	Importance of Central limit theorem
6	Estimation- Point estimation , Interval estimation	Problem solving, Microsoft Excel	Understand Confidence interval as way of hypothesis testing
7	Hypothesis testing- students t, Chi square, Z	Problem solving, Microsoft excel, cases	Use in research

Sr. No.	Content	Activity	Learning outcomes
8	Analysis of variance- one way, two way	Problem solving, Microsoft excel, cases	Use in research
9	Correlation and regression Analysis and significance	Problem solving, Microsoft excel, cases	Understand Model building

Text books

1	Statistics for Management	Richard Levin , David Rubin, Prentice Hall of India
2	Statistics for Managers	Levine, Stephen, Krihbiel, Berenson, Pearson Education
3	Complete Business Statistics	Aczel Sounderpandian, Tata McGraw Hill

Reference books

1	Statistics for Business and Economics	Newbold, Carlson, Thorne, Pearson Education
2	Statistics for Business and Economics	Anderson, Sweeney, Williams, Cengage Learning
3	Data Analysis and Decision Making	Albright, Winston, Zappe, Thomson

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Core**			
Title of the Subject / course	**:**	**Operations Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To expose a student of Management to operations principles.
2	To understand basic operating principles in product and service industry
3	To be able to apply different analytical techniques of operations Management in different industry sectors like hotel, hospital, mall, BPO, Airlines, manufacturing, consulting etc.

Prerequisites if any	Exposure to MS-excel
Connections with Subjects in the current or Future courses	Manufacturing Resources planning and control, Quantitative models in Operations, Operations analytics, Operations applications and cases

Module

Sr. No	Content	Activity	Learning outcomes
1	Introduction to Operations Management, applications in product and service industry, use of competitive advantage	Lecture, examples	Understand the basic concepts and learn how to apply the same.
2	Process analysis in Industry	Lectures, cases	Understand the physical processes
3	Facility location	Lecture, examples	Understand characteristics of equipment, machines and workflow
4	Facility layout	Lecture, examples	Understand characteristics of equipment, machines and workflow
5	Inventory Management, EOQ,ABC analysis, Discount policy	Lecture, examples, cases	Understand how, when, what and how much to order, stock and cost implications
6	Capacity and introduction to aggregate planning, PPC	Lecture, examples, cases	Understand capacity utilization, overall production planning and control
7	Basics of MRP	Lecture, examples, cases	Understand concept of dependency
8	Sequencing techniques	Lecture, examples,	Understand and implement optimal ordering of jobs
9	Introduction to Service Operation management	lecture, examples, cases	Understand application of operation to services
10	Work study and method study	lecture, examples	Understand measurement of time management
11	QC and SQC	lecture, examples	Understand quality and control methods, understand sources of variation and identify them on charts, process improvement

Sr. No	Content	Activity	Learning outcomes
12	ISO systems, Value engineering and analysis	lecture	Understand global standards, cost reduction
13	Introduction to supply chain management	Lecture	Understand basic concept of supply chain
Cases and presentation			

Text books

1 Theory & Problems in Production & Operations Management- S N Chary, Tata McGraw Hill
2 Production & Operations Management -Kanishka Bedi , Oxford University Press

Reference books

1 Production and Operations Management-S N Chary, Tata McGraw Hill
2 Production and Operations Management- Chunawalla & Patel, Himalaya Publishing
3 Operations Management for competitive advantage-Chase & Jacob, McGraw-Hill/Irwin

Assessment

Internal	40%
Semester end	60%

PROGRAMME : MMS

Semester	**:**	**I - Core**			
Title of the Subject / course	**:**	**Managerial Economics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To enable the students to understand both the theory and practice of Managerial Economics,
2	To ensure that the students are in a position to appreciate the finer nuances of the subject.
3	To help the students in applying the knowledge so acquired in policy planning and managerial decision making.

Prerequisites if any	Nil
Connections with Subjects in the current or Future courses	1) This would be a pre-requisite to the second semester paper on Business Environment, which mainly deals with macroeconomic issues, and, 2) Both Managerial Economics and Business Environment papers also constitute the base for studying Strategic Management, which is a University paper in the third semester.

Module

Sr. No	Content	Activity	Learning outcomes
1	Introduction to Managerial Economics: The meaning, scope and methods of Managerial Economics, Dominic Salvatore model of application of Economics to business decision making. Scarcity, choice & production possibility curve.	Lecture& case study	The students should be able to decipher, analyse and apply the theory and practice of Managerial Economics
2	Consumer Behavior- I: Demand, types of demand, factors affecting demand & demand function. Making of linear demand function & linear demand curve. Law of demand. Consumer's surplus	Lecture& case study	Students develop an understanding of a businessman need to locate various factors affecting demand of his product and plan marketing & business strategies accordingly. Students develop an understanding of the practical application of law of demand.
3	Consumer behavior – II: Concept of elasticity of demand and its significance for a businessman. Types of	Lecture& case study	Students develop an understanding of the various concepts and its applications.

Sr. No	Content	Activity	Learning outcomes
	Elasticity – Price Elasticity of Demand, Income Elasticity of Demand, Cross elasticity of demand & Promotional Elasticity of Demand, Demand forecasting – features, significance & methods		
4	**Supply** – concept of supply, factors affecting supply& the law of supply Determination of equilibrium price :effects of changes in demand & supply on equilibrium price	Lecture & case studies	Students should understand the analytics of supply and demand and its various uses.
5	Production Function: Concept, Isoquant &Isocost analysis	Lecture and a case study	Student should get an holistic understanding of production economy.
6	Laws of returns to scale, economies & diseconomies of scale		
7	Revenue Analysis, Cost analysis and break even analysis	Lecture	Students will follow the relationship between costs, revenues, profits and losses
8	Types of markets: perfect competition, monopoly, oligopoly & monopolistic competition – features and price determination	Lectures & case study	Students will learn about the intricacies of the various market forms and their impact on the economy and business.
9	Types of markets: perfect competition, monopoly, oligopoly & monopolistic competition – features and price determination	Lectures & case study	Students will learn about the intricacies of the various market forms and their impact on the economy and business.
10	Pricing practices: Factors affecting pricing decision. Marginal cost pricing, mark up pricing, transfer pricing, product line pricing, price skimming and penetration price.	Lectures & cases	Awareness of students about various pricing practices.
11	• Profit management • Role of profits in a market economy • Nature and measurement of profit, profit policies • The hypothesis of profit maximization and it's alternatives	Lecture	Students learn about the role of profit in business.

Sr. No	Content	Activity	Learning outcomes
12	• Demand for capital • Supply of capital • Capital Rationing • Capital Budgeting, Net Present Value(NPV), Internal Rate of Return(IRR). • Appraising - the profitability of projects	Lecture	Students should realize the importance of the different methods of capital budgeting as a tool of project management.
13	Presentations by students		Students should realize the importance of the different methods of capital budgeting as a tool of project management.

Text books

1	Managerial Economics in a Global Economy by Dominick Salvatore
2	Managerial Economics by Suma Damodaran
3	Microeconomics for Business by Satya P Das

Reference books

1	Economics by Paul Samuelson and Richard Nordhaus : Indian Adaptation, 19th Edition
2	Managerial Economics by Milton Spencer and Louis Siegelman
3	Managerial Economics: Concepts and Cases by Mote, Paul and Gupta

Assessment

Internal	40
Semester end	60

PROGRAM : MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Effective and Management Communication**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	In all social behavior, communication is essential in building and maintaining human relationships.
2	In business, communication is essential for the smooth and efficient conduct of day-to-day transactions/activities.
3	In recent years the importance of communication has greatly increased as a result of the growing complexity of businesses, as also the impact of rapid industrialization, globalization and the advent of modern technologies.
4	English being globally the language of Management, those with good communication skills in English enjoy a distinct advantage in their work and careers.

Prerequisites if any	Decent working knowledge of the English language (including Grammar) is a must, keeping in mind that most business/management transactions in India and internationally are conducted in the English language.
Connections with Subjects in the current or Future courses	English is globally the most widely spoken language and it is the accepted language of the business world. It is the medium of instruction for this course, hence it impacts every subject and future courses.

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction and Theory of Communication: nature, function & scope; The 7 Cs of communication	2 sessions (3 hrs)	Historical background and the development of communication; Importance and role of communication in everyday life
2	The communication Process: classification , components and models of communication; Problems in communication (Filters)	2 sessions (3 hrs)	Mechanics behind the communication process, difficulties experienced in communication
3	Channels of communication: Formal v/s Informal, Upward, Downward, Horizontal, Grapevine; Barriers to communication.	2 sessions (3 hrs)	Different types of communication, impedance due to extraneous factors called “barriers”
4	Verbal and Non-verbal communication: Listening, Kinesics, Paralanguage, Proxemics	2 sessions (3 hrs)	Important non-verbal parameters in communication
5	Essentials of effective verbal communication: Voice modulation, Tone, Pitch,Knowledge and self confidence	2 sessions (3 hrs)	How to make your communication effective and attractive

Sr. No.	Content	Activity	Learning outcomes
6	Meetings: Types; purpose. Group Discussions: Do's and Don'ts; Committees: Types, Advantages and disadvantages, effectiveness.	2 sessions (3 hrs)	Communication in groups, guidelines to improve performance/effectiveness in group interactions
7	Public Speaking: Preparation, Attire, Posture and Delivery techniques	2 sessions (3 hrs)	How to become a convincing and forceful public speaker
8	Written communication: Business letters, Types, Essentials, Format, common errors. e-mail: format, language and courtesy, common errors.	2 sessions (3 hrs)	Ways to achieve impressive and meaningful written communication
9	Report Writing: Types of Reports, requirements, format	2 sessions (3 hrs)	Correct and effective Report-writing techniques
10	Communication and Culture: Intercultural sensitivities, Business etiquette when dealing with people from different nationalities.	4 sessions (6 hrs)	Understanding cultural diversity and Business etiquette with foreign clients
12	Impact of modern Technology on Business Communication: the paperless office, use of modern devices	2 sessions (3 hrs)	Methods of effective audio-visual communication
13	Cases, sample communications and exercises, audio-visual presentations	2 sessions (3 hrs)	Experiential learning through audio-visual means

Text books

1	Singh Nirmal, "Business Communication : Principles, Methods & Techniques," Deep & Deep Publications, Delhi.
2	Krishna Mohan & Meera Banerji, "Developing Communication Skills," MacMillan.
3	Murphy, Hildebrandt & Thomas, "Effective Business Communications," McGraw Hill.
4	Taylor & Chandra, "Communication for Business: A Practical Approach," Pearson
5	Mukherjee Hory Sankar, "Business Communication: Connecting at Work", Oxford University Press, 2013.

Reference books

1	Doctor & Doctor, "Business Communication," Sheth Publishers.
2	Raman & Singh, "Business Communication," Oxford University Press.
3	Madhukar R. K., "Business Communication," Vikas Publishing House
4	McKay, Davis and Fanning, "Communication Skills," B. Jain Publishers Pvt Ltd, New Delhi**.**

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Business Ethics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To have an in-depth knowledge of the issues concerning Morals, Values, Ideologies and Ethics in personal, professional and business lives
2	To prepare the budding managers and entrepreneurs to develop themselves into better corporate citizens
3	To imbibe into students the importance of fair transactions, ethical conduct and conscientious decision making
4	To expect an Integrity-driven work place scenario from students
5	To ensure sustainability as a compulsive tool of driving Organisational Vision and Mission
6	To have a balance between the Theoretical and practical aspects of Ethics in general and Ethics in business in particular.

Prerequisites if any	A thorough understanding of the amalgam of Class Room and Work place driven learning of business studies.
Connections with Subjects in the current or Future courses	1. Perspective Management 2. Ethos in Indian Management 3. Corporate Social Responsibility 4. Organisational Behaviour

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Ethics : Types, Characteristics** Need, Theories, Merits and Limitations. Moral disintegration in contemporary times and need for it to be controlled.	Discussion, Text Book, Electronic Presentations	Getting to know of the basis and basics of Ethics
2	**Role and Features of Business.** How Business and Ethics are to be conjoined used integrally to each other. Merits of using Ethics in Business.Chanakya and Gandhi philosophy.	Discussion, Text Book, Electronic Presentations	The compulsive connection between Business and Ethics. How does it help the Business.
3, 4 & 5	**Theory of Ethics.**Management of Ethics - Ethics analysis [Hosmer model]; Ethical dilemma; Ethics in practice - Ethics for managers; Role and function of Ethical managers- Comparative ethical behaviour of managers; Code of	Discussion, Text Book, Electronic Presentations	Strong knowledge of the theory and written material on Ethics, Integrity and Ideologies

Sr. No.	Content	Activity	Learning outcomes
	ethics; Competitiveness, organizational size, profitability and ethics; Cost of Ethics in Corporate ethics evaluation.		
6	**Business and Ecology** / Environmental issues in the Indian context and case studies. Green Judicial Activism, Green Tribunal , Economic & Environmental Sustainability	Discussion, Text Book, Electronic Presentations	Importance and respect for Ecological Environment. Green Legislations
7, 8	**Compliance and Legal Aspects of Ethics** General and Business Ethics in particular. Political and Legal Environment. Indian Constitution and Ethics, Indian Legal framework, Competition Law, Indian Culture and Values, Concept of Karma, Dharma and Good Conduct	Discussion, Text Book, Electronic Presentations, Seminar by Legal Experts / NGOs, Special Session by experts in Business and Law fields.	Knowledge and respect for Law and natural justice in business. Appreciating the role and importance of respecting the tenets of Natural Law in Business.
9, 10	**Environment of Ethics** Economic Environment. Economic Growth and Business. Relationship between Profitability and Ethics. Role of Chambers of Commerce & Industry in furthering the cause of Ethical aspects of Business. FICCI, CII, IMC etc. Ethics in International Scenario, Ethics and Globalisation, Etiquettes and International mores.	Discussion, Text Book, Electronic Presentations	Role of Government, Trade Bodies, Economy in Business Ethics.
11	**Corporate Governance and Ethics** Code of Conduct, Citizen's Charter, Employee Welfare, Labour Legislations and Privileges, Collective Bargaining, Fair Wage, Sexual Harassment at Workplace, Vishaka V State of Rajasthan guidelines, Future of Governance in Business.	Discussion, Text Book, Electronic Presentations	
12	Live Case Studies, Projects,		

Sr. No.	Content	Activity	Learning outcomes
& 13	Presentations, Submission by Students in Consultation with Industry and Academic Faculty mentors		

Reference books

1	S. A. Sherlekar, Ethics in Management, Himalaya Publishing House.
2	Chandrashekhar, Ethics
3	Chakraborty, Business Ethics

Text books

1	W. H Shaw, Business Ethics
2	Satheesh Kumar, Corporate Governance
3	Hosmer and Richard, The Ethics of Management

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Ecommerce**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives	
1	To understand the Introduction to Electronic Commerce: Meaning, nature and scope
2	To understand the Business to Consumer E-commerce Applications
3	To Understand Business to Business E-Commerce and applications
4	To analysis the Electronic Payment Systems and Order Fulfillment
5	To focus on the Security Issues in E-Commerce
6	To understanding the Management Challenges and Opportunities of E- Commerce:

Prerequisites if any	Basic understanding of E- Commerce
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Management Challenges and Opportunities of E-Commerce to the business

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Introduction to Electronic Commerce: Meaning, nature and scope; Channels of e - commerce; Business applications of e -commerce; Global trading environment and adoption of e-commerce. Business Models of E-commerce and Infrastructure; B2B, B2C, B2G and other models of e-commerce; Applications of e-commerce to supply chain management; product and service digitization; Remote servicing,procurement, and online marketing and advertising E-commerce ,resources and infrastructure planning	Lecture	1. To understand basic concepts of online business 2. To know insides of Ecommerce 3. To know how technology helps bridging gaps in business
2	Business to Consumer E-commerce Applications: Cataloging; Order planning and order generation; Cost estimation and pricing; Order	Lecture & cases	

Sr. No.	Content	Activity	Learning outcomes
	receipt and accounting; Order selection and prioritization: Order scheduling, fulfilling and delivery, Order billing and payment Management; Post sales services.		
3	Business to Business E-Commerce: Need and alternative models of B2B e - commerce; Using Public and private computer networks for B2B trading: EDI and paperless trading: characteristic features of EDI service arrangement; Internet based EDI; EDI architecture and standards; Costs of EDI infrastructure; Reasons for slow acceptability of EDI for trading; E-marketing – Traditional web Promotion: Web counters; Web advertisements.	Lecture	
4	Electronic Payment Systems and Order Fulfillment: Types of payment systems - e-cash and currency servers, e-cheques, credit cards, smart cards, electronic purses and debit cards; Operational, credit and legal risks of e - payment, Risk management options for e - payment systems; Order fulfillment for e –commerce.	Lecture and cases	
5	Security Issues in E-Commerce: Security risks of e-commerce-Types and sources of threats; Protecting electronic commerce assets and intellectual property; Firewalls; Client server network security; Data and message security; Security tools; Digital identity and electronic signature; Encryption approach to e-commerce security. Salient provisions for Security and Privacy, ; Legal and Regulatory Environment for e-commerce, cyber laws in India and their limitations Taxation and e -commerce; Management of Risk: Introduction, Introduction to Risk Management, Disaster Recovery Plans, Risk Management Paradigm		

Sr. No.	Content	Activity	Learning outcomes
6	Management Challenges and Opportunities of E- Commerce: New Business Model, Required Changes in Business Processes, Channel Conflicts, Ethical issues in e –commerce.		
7	Case Studies and Presentations.		

Text books

1	Electronic commerce – A managerial perspectives Efraim Turban , David King , Jae lee

Reference books

1	CIO magazine- www.cio.com
2	Technology Forecast- Price Waterhouse Coopers
3	McKinsey Quarterly- www.mckinseyquarterly.com
4	"XML Web Services Professional Projects" Authors: GeetanjaliArora&SaiKishorePublisher: Premier Press ISBN: 1931841365
5	"Service-Oriented Architecture: A field Guide to Integrating XML and Web Services" Author: Thomas ErlPublisher: Prentice Hall ISBN: 0-13-142898-5

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Organizational Behaviour**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To provide students understanding how and why people behave in organizations as they do, either as individuals or in groups and how their behaviours affect their performance and performance of the organization as a whole.
2	to provide understanding how to effectively modify their behaviour through motivation and leadership for enhanced performance. And also to provide understanding about related concepts such as Org. Structure, Design and Culture.
3	To help students to understand human behaviour in organizations and equip them to enhance their performance as well as performance of the people reporting to them.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction to OB	Lecture	Understand the nature and scope of organizational behavior at individual, group, organizational and societal levels
2	Personality: Meaning and Determinants of Personality	Lecture	Comprehend the meaning and determinants of personality and the effects of perception, attitude and values on work
3	Perception, Attitude and Value	Lecture	Understand the concepts of group dynamics, team effectiveness , team roles and conflict management
4	Motivation Concepts : Motives	Lecture	Distinguish between the various theories of motivation and their application in organizations
5	Group Behaviour and Group Dynamics	Lecture	Define the concept of leadership and distinguish between a number of different leadership theories
6	Organisational Design: Structure, size, technology	Lecture	Identify the different bases of power; and discuss how individuals and groups use power in organizations
7	Leadership: Concepts and skills of leadership	Lecture	Understand the impact of organizational culture and structure on organizational behavior
8	Organisation Development	Lecture	Define the concept and practice of change management and

Sr. No.	Content	Activity	Learning outcomes
			organizational development; with an analytical insight related to application of interventions strategically.
9	Understanding of the Concept of Defence Mechanism; Types of Defence Mechanism; Role of Defence Mechanism in Personality, Perception & Attitude; Significance & Relevance of Defence Mechanism for Interpersonal Relations and Group Dynamics	Video & Role Play	Enhanced understanding of the behavior of superiors, peers and subordinates especially in problem situations and the ways to deal with them more effectively.
10	Case Studies and Presentations		

Text books

1	Any textbook of Psychology of undergraduate course (only for Defence Mechanism)
2	
3	

Reference books

1	Understanding Organizational Behavior – Udai Pareek
2	Organizational Behavior – Stephen Robbins
3	Organizational Behavior – Fred Luthans
4	Organizational Behavior – L. M. Prasad (Sultan Chand)
5	Organisational Behaviour – Dipak Kumar Bhattacharya – Oxford Publications
6	Organisational Behaviour – Dr Chandra sekhar Dash – International Book House Ltd
7	Organisational Behaviour – Meera Shankar – International Book House Ltd
8	Management & Organisational Behaviour – Laurie Mullins – Pearson Publications
9	Organisational Behaviour, Structure, Process – Gibson – McGraw Hill Publications
10	Organisational Behaviour – McShane – McGraw Hill Publications

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Introduction to creativity & Innovation Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To make students aware of their own creative potential and the various ways that each one can contribute to innovation in an organization context
2	To learn tools and techniques for creativity and Innovation
3	To appreciate the importance and impact of innovation in todays business context
4	To understand the process of innovation
5	To understand the various issues related to managing innovation in an organization context

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	What is creativity and innovation - importance and impact	Lecture/ small in-class exercises	• Students realize that every one is inherently creative – and they need to nurture this creativity • Students understand the difference and relationship between such terms as creativity, invention , innovation etc
2, 3 & 4	Tools for Creativity	Workshop style activities	Students are exposed to various tools and approaches to stimulating creativity and innovation. Some of these could include – Viewing from Multiple (stakeholder perspective), Lateral Thinking, 6 Thinking Hats, Brainstorming, Use of Analogies and metaphor, Problem reframing etc
5	Basic concepts of Innovation,Types of Innovation	Lecture	Students are now familiar with the various concepts and vocabulary related to innovation – such as incremental innovation, 4Ps of innovation, Disruptive innovation , Innovation in products, processes, experiences, business model etc
6	Historical perspective on innovation in products, processes, business etc	Lecture	Students begin to appreciate how innovations have taken place over the past several decades – the historical perspective sensitizes them to the various drivers and factors which led to or deterred these innovation. These could include but not limited to laws, government initiatives in terms of policy and R&D spends, technology

Sr. No.	Content	Activity	Learning outcomes
			available, etc. They also learn about various milestones – and realize that a timeline based study of any industry could help identify triggers/opportunities for innovation –
7,8	Over view of the Innovation process	Lecture/video eg IDEO's Shopping cart video/ small in-class exercise to help students actually experience the innovation process – from observation to ideation, concept development, prototyping etc	• Student learns the importance of each stage of the innovation process and how to work through each stage • The stages understood include contextual inquiry/ immersive study, insight development, ideation , concept development, prototyping , validation
9	Innovation processes and practices in Highly Innovative companies	Lecture/Discussion	Students understand how various leading innovative companies such as IDEO, Apple, Samsung, 3M, Google etc innovate and develop a comparative understanding of their approach , tools and techniques and processes for innovation
10	Developing an Innovation culture	Lecture	• Students understand the basic concept of culture , the elements of and the unique attributes of a culture for innovation • Students realize the barriers to innovation in an organization context and how these could be overcome
11	Managing an Innovation project	Lecture/ case /examples to highlight challenges faced in managing innovation	Students develop and understanding of the various problems faced in managing an innovation project in an organizational context and how can it be managed effectively as a project
12 and 13	Strategic innovation Management	Lecture	• Students realize how Innovation can provide a competitive advantage • Students become familiar with strategic innovation methods/ frameworks used at a strategic level such as Blue Ocean Strategy, Scanario planning , Osterwalder's Business Model Canvas etc • Students realize how innovation can help in creating Intellectual property which can be create entry barriers for competition • Students also become familiar with the

Sr. No.	Content	Activity	Learning outcomes
			challenges of evaluating innovation either for recognition or funding
14	Presentations & Case Studies/		
15	Presentations & Case Studies/		

Text books

1	Innovation management – Besant and Tidd
2	Innovation and Entreprenuership – Besant and Tidd
3	Ten Rules of Strategic Innovation – Vijay Govindrajan

Reference books

1	Ten Faces of Innovation – Tom Kelly
2	Design Lead Innovation by Prof Sten Ekman et all
3	Edward DeBono – books related to Lateral thinking, 6 thinking hats
4	The Innovator's Dilema – Clayton Christensen
5	Business Model innovation by Osterwalder
6	The Art of Innovation – Tom Kelly

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Foreign Language (Other than English)Chinese**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	China is the world's fastest growing economy and hasbecomes the factory of the world, also the world's supply chain and logistics is heavily focused towards China. China being one of the few countries in the world which has not adopted English it becomes imperative to learn Chinese to enable business dealings with the country.
2	Many multinationals have invested in China, because of the cheap labor and other such comprehensive factors available here we can take the example of Apple which manufactures most of its phones in China There is hardly any country that does not have business dealings withChina. Thereforethe advantage of learning this language is huge.
3	The course should be able to enable basic communication in Chinese so that one can understand simple Chinese words and phrases
4	To be able to use Chinese in everyday situations such as greeting a person asking for directions in short to be able to interact in a simple manner.
5	Carry out simple conversations with Chinese people.
6	Read and write simple phrases in pinyin (spelling Chinese words with the western alphabet) Read signs written in Chinese and be able to read simple notices documents and articles written in Chinese
7	Understand the elements of Chinese characters and evaluate the advantages as well as limitations of a pictographic writing system in contrast with western writing systems Understand the construction of Chinese characters recognizing approximately 120 Chinese characters as well as the radicals
8	Reflect on cultural differences and similarities between Indian and Chinese societies, for example with regard to housing and family relationships and gender roles as well as treatment of minorities and the elderly.

Prerequisites if any	none
Connections with Subjects in the current or Future courses	none

Module

Sr. No.	Content	Activity	Learning outcomes
1	• Course introduction. • Chinese pronunciation and the five tones. • Chinese sentence structure and grammar.	1sessions 3 hours each	Preparatory foundation to be able to progress towards learning the language
2	• Simplified Chinese characters and Pinyin Romanization system. • Greeting and Introducing each other. • Meeting family members. • The verbs 姓 (xìng), 叫 (jiào), 是 (shì) and有 (yǒu).	2 sessions of 3 hours	Able to converse in rudimentary Chinese Example (你好! !How do you do?) Able to make simple inquiry

Sr. No.	Content	Activity	Learning outcomes
	• The adverbs 不 (bù), 也 (yě), 都 (dōu). • The particles 的 (de). • Usage of 二 (èr)/两 (liǎng). • Questions ending with 吗 (ma) and 呢 (ne), questions pronouns. • Measure words.		(你是哪国人？Where do you come from?)
3	Routine and everyday aspects Dates & Time – taking someone out to eat on his/her birthday and inviting someone to dinner. Hobbies – Talking about hobbies and would you like to play ball? Visiting friends – visiting a friend's home and at a friend's house. Asking Directions Direction and Location Words Direction and Location Words Comparative Sentences with 没(有) (méi{yǒu}) 3 那么(nàme) Indicating Degree 4 到(dào) + Place + 去(qù) + Action Going to Chinatown Seeing a Doctor Seeing a Movie Turning Down an Invitation Renting an Apartment Traveling to Beijing Checking In at the Airport Arriving in Beijing	3sessions of 3 hours	Have a high comfort level if visiting China or if entertaining Chinese visitors to India
4	The adverbs还 (hái) and 才 (cái). The particles吧 (ba) and 了 (le). The conjunction 那么 (nàme). The modal verb 想 (xiǎng). The preposition 在 (zài). Numbers (0, 1–100). Dates and time. Word order in Chinese. Alternative questions, affirmative + negative (A-not-A) questions, questions with 好吗 (hǎo ma). 去 (qù) + action. Verb + object as a detachable compound. 一下 (yíxià) and 一点儿 (yìdiǎnr) moderating the tone of voice	2 sessions 3 hours	Learn to write simple words
5	covers the following topics: 开学, 宿舍，在饭馆儿，买东西, 选课. Adverbs 真 and 难道.	2 session 3 hours	Construct simple sentences

Sr. No.	Content	Activity	Learning outcomes
	Dynamic particle 了. Preposition 至于. The 是…的… construction. 除了…以外; 再说; 得很; 那(么). 一 + v; 又adj/verb, 又adj/verb. Emphatic 是; 无论…, 都… Conjunction 于是; adj/v+是+adj/v, 可是/但是…再, 又, and 还 compared. 要么…, 要么…. Also connecting sentences, existential sentences, conjunctions, topic-comment sentence structure, resultative compliments. Words and phrases include 恐怕 (I'm afraid; I think perhaps), 差不多 (about; roughly), 一般 (generally speaking), 不怎么样 (not that great; just so-so), 这(就)要看…(了) (that depends on...) , 比如(说) (for example), …什么的 (…Etc.), (要) 不然 (otherwise), 非…不可 (have to; must), 受不了 (unable to bear), 不过 (but), 这样 (in this way		
6	having students learn to **write** traditional or simplified characters progressing to simple paragraphs and essays	2 session 3 hours	Be able to write simple paragraphs or articles
7	• Geography, climate, people. • Ethnicities, religion, government. • Chinese culture & Business etiquette. • Cultural differences & sensitivities	1 session 3 hours	Important to be able to understand and respond to cultural differences and respect them

Text books

1	Integrated Chinese, Level 1, Part 1, Textbook (website http://ic.cheng-tsui.com/)
2	Integrated Chinese, Level 1, Part 2, Textbook
3	Integrated Chinese, Level 1 Part 1 Character Workbook, 3rd Edition (Simplified & Traditional)

Reference books

1	New Practical Chinese Reader 2 Dvd (Only) (English And Chinese Edition)Jan 1, 2005by Liu Xun
2	Practical Audio-Visual Chinese 1 2nd Edition (Book+mp3) (Chinese Edition) Oct 1, 2008by Guo Li Tai WAN Shi Fan Da XueGuo Yu Jiao XueZhongXin
3	Colloquial Chinese: The Complete Course for Beginners (Colloquial Series)2nd Edition ISBN-13: 978-0415434157 ISBN-10: 0415434157

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Negotiation & Selling Skills**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	The module will sensitize the students to the concepts and importance of Negotiations & Selling for all functions of Management.
2	The module is designed to introduce the students to the basic elements of the selling
3	The module will give the students a broad understanding regarding different models used for effective selling and negotiations.
4	It also creates awareness among the students about the basic qualities, traits and skills that they need to imbibe to be an effective management professional.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Meaning, Definition & Importance of Negotiation in Management, Types of Negotiation		Developing basic understanding of students related to Negotiation.
2	Understanding Negotiation Framework including Legal Aspects, Negotiation Process, Skills of a Negotiator		Providing deeper insight relatedto Negotiation framework
3	Negotiation Models (BATNA, Dyad, ZOPA, 9 Grid) & Strategies, Understanding Barriers to Agreement		Familiarizing students with basics of models in negotiation and strategies
4	Introduction to Marketing & Selling Concepts & Traits of a Successful Salesperson	Role Play on Negotiation	Introducing students to understand the difference between Marketing and Selling and giving them useful tips for succeeding in Sales
5	Understanding Successful Selling Process & Models (7 Steps Model)		Introducingstudents to understand the difference between Marketing and Selling and giving them useful tips for succeeding in Sales
6	Customer Focussed Selling, Art of Persuasion		Creating awareness about importance of customer in selling process

Sr. No.	Content	Activity	Learning outcomes
7	Selling to Various Stakeholders such as Dealers, Suppliers, Vendors, Channel Partners, Superiors, Subordinates, Team- Mates & Peers	Guest Session with industry experts	Familiarizing students with different approaches required For selling different stakeholders
8	Selling to Customers – B2C, B2B, C2C, Products, Services, Intangibles & Projects		Familiarizing students with different approaches required for selling to different segments of customers.
9	Strategic Selling for Start-ups	Guest Session with industry experts	Creating awareness about challenges and opportunities available in Start-ups domains
10	Body Language for Negotiation & Selling	Role Plays on Selling	To enhance effectiveness of a Salesperson by understanding Clues provided by body language.
11	Case Studies and Presentations		

Activity: In addition to classroom teaching, the Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Text books

1	The Essentials of Negotiation – Harvard Business School Press
2	Negotiations Selling by Sameer Kulkarni – Excel Books
3	Negotiation & Selling by R. K. Srivastava – Excel Books

Reference books

1	Organizational Behavior by Fred Luthans (9th edition)
2	Managing Conflict & Negotiation by B. D. Singh – Excel Books
3	Getting to Yes by Roger Fisher & William Ury –Random House
4	Negotiation Handbook by P. J. Cleary – Printice Hall of India
5	ABC's of Selling Skills by Charles M. Futrell – McGraw Hill
6	Sales Management Analysis and Decision Making by Thomas Ingram & Raymond LaFarge – Published by DRYDEN
7	How to Handle Conflict & Confrontation by Peg Pickering – Natl Seminars Publications

Assessment

a)	Internal	40%	40 Marks continuous assessment
b)	Semester End Examination	60%	60 Marks theory paper of 3 hours duration

PROGRAM: MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**IT Skills for Management and Technology Platform**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To have the basics practical skills of information Technology(i.eHardware - Software , Database, Networking, Communication Technology)with its application and usage.

Prerequisites if any	Basic understanding of IT Skills for Management and Technology Platform
Connections with Subjects in the current or Future courses	Will connect and have application of information technology and technology platform skills

Module

Sr No.	**Content**	**Activity**	**Learning outcomes**
1	To, understand the conceptual background of Hardware - Software – (Systems Software, Application Software and Packages) Introduction and Fundamentals of operating system- Windows, Unix/Linux. Introduction and knowledge of Internet operations. World Wide Web , Emerging communication technologies	Lecture	
2	Introduction to Software Packages & practical knowledge of **Microsoft Word** **Microsoft Excel** – Formulas, Graphs, Basis statistical formulae. **Microsoft Power Point** – Creating effective presentations **Microsoft Access** - Introduction to DBMS concepts, creating a database, Basic queries. **Tally –** Journal Entry, Ledger posting, Preparation of Balance Sheet Emerging technology of office Automation systems **Lab Sessions of Document Preparation & Presentation Skills**	Lecture & cases	1. To know data analysis and database management with Microsoft Excel 2. To know management of data using Microsoft Access 3. To know how to prepare interactive business presentation
3	**Practical hands on experience of Internet and Web Technology**	Lecture	

	Internet Technology Understanding Websites Understanding Domain Names & Domain Extensions Web Server & Web hosting Web Designing ,Home page designing Website Content designing, Joomla, query, knowing & Adding Payment Gateways, Web Hosting, Mobile Technology & Business On-line Business Mechanism Hands on experience of Emerging communication technology **Lab Sessions**		
4	**Case Study and Practical Exercises With Lab Sessions**	Lecture and cases	

Text books

1	Work-study by ILO

Reference books

1	Rajaraman, V. (2004). Introduction to Information Technology.PHI.
2	Turban, Rainer and Potter (2003). Introduction to information technology.John Wiley and sons
3	Sinha, P.K., PritiSinha (2002). Foundation of computing.BPB Publications.
4	Ram, B. (2003). Computer Fundamentals. New Age Publication

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Information Technology for Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To understand the significance of information technology , conceptual framework of networking, communication technology, database etc. for individual & business management
2	To understand role , impact and emerging trends of information technology for management and its application at individual ,organizational level society and similarly for business alignment.

Prerequisites if any	Basic understanding of Information Technology for management
Connections with Subjects in the current or Future courses	Will connect conceptual framework of Information Technology for Management at individual and organizational level.

Module

Sr. No.	Content	Activity	Learning outcomes
1	Historical perspective of information technology and business.	Lecture	1. Learning of basic concepts and components of IT 2. Learning different application of computer and IT in business 3. Application of It across the industries
2	Functioning of computer hardware and software components, characteristic from user and buyers perspectives.	Lecture & cases	
3	Introduction and conceptual framework of networking & Telecommunication, components of networking, LAN/WAN/MAN, network topologies, and various option of networking for business, various medium of communication, physical and cable less (dial up, leased line, satellite , V- SAT, DSL Lines , fiber optics)	Lecture	
5	Role and emerging trends of information technology Overview of concept such as ERP,SCM, CRM, database management, DBMS Data warehousing, Business intelligent, knowledge Management, E- Commerce, E-Business, M- Commerce, Digital Business , E-governance.	Lecture and cases	
6	Impact of information on business, business alignment across the function and sectors and society	Lecture & Cases	
7	Case study and presentation	Lecture & Cases	

Text books		
1	Information Technology for Management	by Rainer , Porter and Turban.
2	Introduction to information technology	byRajaramman.
3	Information technology for Management	DrChandrahaunschavan& B lal

Reference books	
1	E- Business: road map for success, Ravi Kolkata and Marcia Robinson.
2	Competitive strategic by Michael Porter
3	Electronic commerce – A managerial perspectives Efraim Turban , David King , Jae lee
4	Principles of information Systems by ralph stair & George Reynolds

Assessment	
Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**I - Elective**			
Title of the Subject / course	**:**	**Personal Grooming / Personal Effectiveness**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	Identify personal thinking habits and their impact
2	Understand and address the barriers to personal effectiveness
3	Apply clear and effective communication skills
4	Develop effective time management skills and the ability to cope with stress

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Know Yourself – Self Discovery		Know yourself (Your Values, Abilities and Goals)
2	Developing a Positive Attitude and Values		Identify influences of their attitudes towards success, achievement, and disappointment both in personal and professional lives
3	Grooming - Corporate Etiquette and Manners		Enhancing corporate and social Image, learning grooming basics and personal hygiene management
4	The Art of Listening		An understanding of the key role listening plays in the ability to solve problems, work effectively with customers, and be a valuable team member.
5	Body Language		Using body language to increase your personal impact
6	The Art of Speaking		Ability to communicate competently in groups and organizations
7	GD and PI Skills		Augment skills related to this important dimension of the selection process in organizations
8	Written Business Communication		Organize and present information for maximum impact and clarity
9	CV. and Resume writing		Understand and write a functional resume , versus a chronological resume, writing cover letters

Sr. No.	Content	Activity	Learning outcomes
10	Working in Groups and Teams		Enhance capabilities to lead and succeed and for that you need to be a good team player
11	Time Management		Identify typical time-wasters and create solutions to overcome them
12	Stress Management		Ability to deal with stress and pressure effectively
13	Career Planning		How to develop a personal development plan

Text and Reference books

1	Super Self: Doubling Your Personal Effectiveness by Charles Given
2	The 3 Pillars of Personal Effectiveness by TroelsRichte
3	The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change by Stephen R. Covey
4	Personality Development and Soft skills by BarunMitra

Internal	40%
Semester end	60%

UNIVERSITY OF MUMBAI , MUMBAI

Masters in Management Studies - Semester II (CBGS)

with effect from Academic Year 2016-17

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper	No of Credits
1	Marketing Management	27	2	40 IA	60 IA	100	3hr	4
2	Financial Management	27	2	40 IA	60 IA	100	3hr	4
3	Operations Research	27	2	40 IA	60 IA	100	3hr	4
4	Business Research Methods	27	2	40 IA	60 IA	100	3hr	4
5	Human Resource Management	27	2	40 IA	60 IA	100	3hr	4

3 ELECTIVES OUT OF 10								
1	Legal & Tax Aspects of Business	27	2	40 IA	60 IA	100	3hr	4
2	Cost & Management Accounting	27	2	40 IA	60 IA	100	3hr	4
3	Business Environment	27	2	40 IA	60 IA	100	3hr	4
4	Ethos in Indian Management	27	2	40 IA	60 IA	100	3hr	4
5	Corporate Social Responsibility	27	2	40 IA	60 IA	100	3hr	4
6	Analysis of Financial Management	27	2	40 IA	60 IA	100	3hr	4
7	Entrepreneurship Management	27	2	40 IA	60 IA	100	3hr	4
8	Management Information Systems	27	2	40 IA	60 IA	100	3hr	4
9	Developing teams & Effective leadership	27	2	40 IA	60 IA	100	3hr	4
10	Intellectual Capital and Patenting	27	2	40 IA	60 IA	100	3hr	4
							Total No of Credits	**32**

UA: University Assessment **IA: Internal Assessment**

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester II

Sr. No.	Core	Sr. No.	Electives (Any 3)
1	Marketing Management	1	Legal & Tax Aspects of Business
2	Financial Management	2	Cost & Management Accounting
3	Operations Research	3	Business Environment
4	Business Research Methods	4	Ethos in Indian Management
5	Human Resource Management	5	Corporate Social Responsibility
		6	Analysis of Financial Statements
		7	Entrepreneurship Management
		8	Management Information System
		9	Developing teams & Effective leadership
		10	Intellectual Capital and Patenting

Note:

1 All subjects / papers for Semester II will be internally assessed by the institute. The Criteria for the same is given below

a) Attendance and Class Room Participation 10 Marks

b) Minimum 3 criteria to be picked up from the below given list

- Mid term Test (Min 1)
- Group Presentation
- Role Plays
- Case Studies
- Assignments
- Projects
- Quiz

2 Institute will have the discretion to select minimum 3 (three) subjects or more from given list of 10 subjects. Total 32 credits has to be obtained.

3 Any new elective proposed to be introduced by the Institute, apart from electives listed in the new syllabus, need to take prior approval from Board of Management Studies of the University in writing outlining the details of the course with learning objectives, learning outcomes, detailed syllabus, teaching learning plan and course evaluation procedures atelast 6 months in advance before the commencement of the semester.

PROGRAM : MMS

Semester	**:**	**II - Core**			
Title of the Subject / course	**:**	**Marketing Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	This coursework is designed to introduce the student to the basic elements of the marketing management terms, implementation of studied term in the industry and related process.
2	The scope of marketing management is quite broad and the students will be exposed to the marketing concepts that will enable them to acquaint with contemporary marketing practices.
3	This module is to learn the art and science of choosing target markets and getting, keeping and growing customers through creating, delivering, and communicating superior customer value.
4	This module will give the student a very broad understanding of what marketing is all about and the vital role that it plays in every organization, every department and every specialization.
5	The module will help the student to identify and solve many business problems by using a marketing perspective, as a universal concept.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	**Content**	**Activity***	**Learning outcomes**
1	Introduction to Marketing Concept Evolution of Marketing from Production to Sustainability & Customer Orientation		Students will develop basic understanding of concepts in the marketing with respect to historical development of the subject
2	Understanding the Basics: Concept of Need, Want and Demand Concept of Product and Brand Business Environment in India Demand States & Marketing Tasks Company Orientation towards the Market Place		Making students familiar with the Fundamental concepts and vocabulary or practices from business perspective in the Organization.
3	Marketing Environment : Marketing Environment and Evaluation of Market Opportunities like Services, Rural & International		Understanding of the Marketing environment to help students to compare various opportunities available in various sectors.
4	Market Research & Marketing Information Systems and Demand		To familiarize students with various concepts relatedto

Sr. No.	Content	Activity*	Learning outcomes
	Forecasting and Market Potential Analysis		market research and its utility.
5	Consumer Buying Process & Organizational Buying Behaviour		Helping students to focus on Important issues related to success in consumer buying behavioural process vis a vis organizational buying behaviour process.
6	Pillars of Marketing - Market Segmentation, Target Marketing, Positioning & Differentiation		Imparting knowledge of various important marketing concepts.
7	Marketing Mix and Product Decisions – Product Life Cycle, & Brand		Various practices related to The important aspects of marketing in decision Making
8	New Product Development Process		Understanding mechanism of developing a new product related process
9	Pricing Decisions		To understand the pricing dynamics being practiced by the organizations in different Sectors
10	Distribution Decisions – Logistics & Channel Decisions (Retail, E-commerce, etc.)		Understanding of operational issues in order to support marketing-process
11	Promotion Decisions – Integrated Marketing Communications Concept: Advertising, Sales Promotions, Public Relations, Direct Marketing; Communication Tools		To familiarize students with various concepts relatedto Communication Design Process in effective marketing practices
12	Personal Selling & Sales Management		To understand the important aspects direct marketing in the Changing circumstance with the help of latest development
13	Overview of Marketing Strategies: BCG, Ansoff, GE, Shell Model, Porter Generic Model, 5 Forces Model, PLC, 7s Model of Marketing, A Little Model, Value Chain Model		To make students understand basics of various models and their application in their field of work
14	Case Studies and Presentations		

*Activity: In addition to classroom teaching, the Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Text books

1	Marketing Management (A South Asian Perspective) by Philip Kotler, Kevin Lane Keller, Abraham Koshy & Mithileshwar Jha, Pearson Education
2	Marketing Management by R. Varshney, S. Chand
3	Marketing Management by Rajan Saxsena, Tata McGraw Hill

Reference books

1	Basic Marketing by Jr., William Perreault, Joseph Cannon and E. Jerome McCarthy
2	Marketing Management – Planning, Implementation and Control by V.S. Ramswamy and S. Namakumari, McMillian
3	Business Marketing Management by M. Hutt, Cengage Learning

Assessment

a)	Internal	40%	40 Marks continuous assessment
b)	Semester End Examination	60%	60 Marks theory paper of 3 hours duration

PROGRAM: MMS

Semester	**:**	**II - Core**			
Title of the Subject / course	**:**	**Financial Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To gain in-depth knowledge of corporate finance and understand the functions of finance management.
2	Students should learn to analyze corporate financial statements and other parts of the annual report.

Prerequisites if any	Knowledge of financial accounting
Connections with Subjects in the current or Future courses	This will work as the basic subject for the elective subjects coming in the second year

Module

Sr. No.	Content	Activity	Learning outcomes
1	Objective of financial management Functions and decisions of financial management Indian Financial system - Functions of the financial system; Financial Assets; Financial markets; Financial intermediaries; Regulatory system	Lecture and theoretical discussion	Understanding the basic concepts of corporate finance and Indian financial system
2	Financial performance analysis using Ratio Analysis	Lecture, exercises and assignment	Ability to analyse the financial statements of companies using ratios
3	Working Capital Management - Estimation and Financing Inventory Management Receivables Management Cash Management	Lecture, exercises and case discussion	Ability to calculate the working capital requirements; analyse working capital policies and understanding operating and cash cycle
4	Financial Planning and Forecasting Meaning and importance of financial planning Approaches to financial planning Preparation of Pro-forma Income Statement and Balance Sheet Computation of external financing requirements	Lecture and exercises	Ability to prepare pro-forma financial statements and calculate the EFR
5	Investment (Project) identification, feasibility analysis with sensitivities, constraints and long term cash flow projection Capital Budgeting and Investment Decision Analysis	Lecture, exercises and case discussion	Ability to use various evaluation techniques like NPV, IRR, PI, payback period etc. for evaluating capital expenditure decision
6	Sources of Finance - Short Term and Long Term	Theoretical discussion	Understanding the features and characteristics of various financing options
7	Theory of capital structure: Net income approach; Net operating income approach; MM approach; Traditional approach	Lecture and exercises	Understanding different capital structure theories and the impact of D/E ratio on EPS

Sr. No.	Content	Activity	Learning outcomes
8	Capital Structure Planning and Designing capital structure based on EBIT and EPS/MPS approach Factors affecting capital structure	Lecture and exercises	Ability to design the optimal capital structure
9	Capital Structure Planning and Leverage Analysis: Operating, financial and total Capital Structure Planning and cost of capital	Lecture and exercises	Ability to calculate DOL, DFL and DCL
10	Dividend Policy: Factors affecting dividend policy decision; Dividend decision models; Walter model; Gordon model; MM approach	Lecture and exercises	Understanding the impact of dividend payout ratio and retention ratio on company's financial position

Text Books

1	Financial Management – M.Y. Khan and P.K. Jain
2	Financial Management – Prasanna Chandra

Reference Books

1	Financial Management – I. M. Pandey
2	Principles of Corporate Finance – Myers and Brealey
3	Fundamentals of Financial Management – James Van Horne
4	Financial Management: theory and practice – Brigham Eugene F; Ehrhardt, Michael C.

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**II - Core**			
Title of the Subject / course	**:**	**Operations Research**			
Course Code	**:**	**For Office use**			
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40hrs**

Learning Objectives

1	To know optimizing techniques
2	To understand its use in decision making in business
3	To Identify and develop operational research model from realsystem
4	To appreciate the mathematical basis for business decision making

Prerequisites if any	Statistics for management, Operations and production management, economics
Connections with Subjects in the current or Future courses	Project Management, Quantitative Techniques,

Module

Sr. No.	Content	Activity	Learning outcomes
1	Linear Programming- Formulation, Solution by graph, Simplex, Duality, post optimality and Sensitivity Analysis	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand application in business. Data Envelopment Analysis as extension of LPP model
2	Transportation problem with special cases	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand special cases of LPP and apply in appropriate situation
3	Assignment Problem with special cases	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand special case of LPP and apply in appropriate situation
4	Game theory- Zerosum games	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand Competitive environment of business
5	Decision Theory- Under Risk, Uncertainty, decision tree	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand project management techniques
6	Waiting lines model- (M|M|1):(FIFO|∞|∞) with cost implication	Use of Solver/ similar software for decision making, cases in various scenarios of management	Understand queue model as a measure of performance of system
7	Simulation- queue system, inventory and demand simulation	Create models in Microsoft Excel	In want of assumptions of the model a working system can be created

Text books

1	Operation Research – AN introduction- HamdyTaha, Prentice Hall Of India
2	Quantitative Techniques in Management -N D Vohra, Tata McGraw Hill
3	Operations Research Theory and Applications- J K sharma, Macmillan Business books

Reference books

1	Principles of Operations Research –Wagner, Prentice Hall of India
2	Operations Research- Hilier, Liberman, Tata McGraw HIll
3	An introduction to Management Science – Anderson Sweeney Williams, Cengage Learning

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**II**			
Title of the Subject / course	**:**	**Business Research Methods**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To understand the importance of research and various methods that researcher used to investigate problems
2	Applying Modern Analytical tools for Business Management Decisions
3	To derive strategies from the research
4	To understand the challenges in collecting the data collection and analysis
5	To interpret the data to make meaningful decisions.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction to Research	Lecture	Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research; Research applications in social and business sciences; Features of a Good research study.
2	Research Problem and Formulation of Research Hypotheses	Lecture	Defining the Research problem; Management Decision Problem vs Management Research Problem; Problem identification process; Components of the research problem; Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal- Contents of a research proposal and types of research proposals.
3	Research Design	Lecture	Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross-sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design
4	Primary and Secondary Data	Field Work	Classification of Data; Secondary Data: Uses, Advantages, Disadvantages, Types and sources; Primary Data Collection: Observation method, Focus Group Discussion, Personal Interview method

Sr. No.	Content	Activity	Learning outcomes
5	Attitude Measurement and Scaling	Lecture	Types of Measurement Scales; Attitude; Classification of Scales: Single item vs Multiple Item scale, Comparative vs Non-Comparative scales, Measurement Error, Criteria for Good Measurement
6	Questionnaire Design	Lecture	Questionnaire method; Types of Questionnaires; Process of Questionnaire Designing; Advantages and Disadvantages of Questionnaire Method
7	Sampling and Data Processing	Case Study and SPSS / Excel	Sampling concepts- Sample vs Census, Sampling vs Non Sampling error; Sampling Design- Probability and Non Probability Sampling design; Determination of Sample size- Sample size for estimating population mean, Determination of sample size for estimating the population proportion Data Editing- Field Editing, Centralized in house editing; Coding- Coding Closed ended structured Questions, Coding open ended structured Questions; Classification and Tabulation of Data.
8	Univariate and Bivariate Analysis of Data	SPSS Lab / Excel	Descriptive vs Inferential Analysis, Descriptive Analysis of Univariate data- Analysis of Nominal scale data with only one possible response, Analysis of Nominal scale data with multiple category responses, Analysis of Ordinal Scaled Questions, Measures of Central Tendency, Measures of Dispersion; Descriptive Analysis of Bivariate data
9	Testing of Hypotheses	Analyzing Primary Data	Concepts in Testing of Hypothesis – Steps in testing of hypothesis, Test Statistic for testing hypothesis about population mean; Tests concerning Means- the case of single population; Tests for Difference between two population means; Tests concerning population proportion- the case of single population; Tests for difference between two population proportions.
10	Chi-square Analysis	Analyzing Primary Data	Chi square test for the Goodness of Fit; Chi square test for the independence of variables; Chi square test for the equality of more than two population proportions
11	Analysis of Variance	Lecture and Analyzing Primary Data	Completely randomized design in a one-way ANOVA; Randomized block design in two way ANOVA; Factorial design
12	Research Report Writing and Ethics in research	Lecture	Types of research reports – Brief reports and Detailed reports; Report writing: Structure of the research report- Preliminary section, Main report, Interpretations of Results and

Sr. No.	Content	Activity	Learning outcomes
			Suggested Recommendations; Report writing: Formulation rules for writing the report: Guidelines for presenting tabular data, Guidelines for visual Representations. Meaning of Research Ethics; Clients Ethical code; Researchers Ethical code; Ethical Codes related to respondents; Responsibility of ethics in research
13	Presentation / Report	PowerPoint	

Text books

1	Business Research Methods – Cooper Schindler
2	Research Methodology Methods & Techniques – C.R.Kothari
3	Statistics for Management – Richard L Levin

Reference books

1	D. K. Bhattacharya: Research Methodology (Excel)
2	P. C. Tripathy: A text book of Research Methodology in Social Science(Sultan Chand)
3	Saunder: Research Methods for business students (Pearson)
4	Marketing Research –Hair, Bush, Ortinau (2nd edition Tata McGraw Hill)
5	Business Research Methods – Alan Bryman& Emma Bell – Oxford Publications
6	Business Research Methods – Naval Bajpai – Pearson Publications

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**II - Core**			
Title of the Subject / course	**:**	**Human Resource Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To prepare a student for a career in industry and services.
2	To facilitate learning in modern concepts, techniques and practices in the management of human resources
3	To expose the student to different functional areas of Human Resource Management to enhance the effectiveness.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Human Resource Management	Lecture	Apply the theoretical and practical aspects of human resource management to formulate strategies that will enable organizations to achieve both operational and strategic goals related to the organization's human capital.
2	Organization of Personnel Functions	Lecture	Understand the scope of HRM and its relationship to other social sciences
3	Manpower Planning	Lecture	Study the personnel function with respect to its organization , polices and responsibilities in an organization
4	Motivating Employees –	Lecture	Understand the importance and the process of man power planning, the process of job analysis, compare and contrast methods used for selection and placement of human resources.
5	Performance Appraisal Systems	Lecture	Understand the application of the theories of motivation , explaining the difference between internal and external equity in terms of monetary and non-monetary rewards and recognition
6	Training & Development –	Lecture	Discuss the importance and process of performance management, organizational strategic planning and succession planning.
7	Organisation Development –	Lecture	Describe the steps required to analyze needs , develop and evaluate an employee training and development programs in organizations

Sr. No.	Content	Activity	Learning outcomes
8	Management of Organizational Change	Lecture	Define the concept and practice of change management and organizational development; with an analytical insight related to application of OD interventions strategically
9	HRD Strategies for Long Term Planning & Growth	Lecture	
10	Case Studies and Presentations		

Text books

1	Human Resource Management – P.SubbaRao
2	

Reference books

1	Personnel Management – C.B. Mammoria
2	Dessler: Human Resource Management(Prentice Hall India)
3	Personnel/Human Resource Management: DeCenzo& Robbins (Prentice Hall India)
4	D. K. Bhattacharya: Human Resource Management (Excel)
5	VSP Rao – Human Resource Management(Excel)
6	Dessler: Human Resource Management(Prentice Hall India)
7	Personnel/Human Resource Management: DeCenzo& Robbins (Prentice Hall India)
8	Gomez: Managing Human Resource (Prentice Hall India)
9	Human Resource Management – Dr P Jyothi and Dr D.N Venkatesh – Oxford Publications

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**II - Elective**			
Title of the Subject / course	**:**	**Legal Aspects of Business & Taxation 100 Marks**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To learn about the important provisions of some of the important business laws
2	To get exposure to important provisions of Indian Income Tax Act and Indirect Taxes

Prerequisites if any	None
Connections with Subjects in the current or Future courses	Students in all the specialisations must have a minimum knowledge of important business laws. The applications of law will be in many subjects they will study in the second year

Module

Sr. No.	Content	Activity	Learning outcomes
1	The Indian Contract Act, 1872	Lecture and case law discussion	Understanding the law and concepts of parties to the contract, consideration and other legal concepts related to a Contract
2	The Sales of Goods Act, 1930	Lecture and case law discussion	Understanding the meaning of sale of goods and the rights and duties of vendor and consumer under the Act.
3	The Negotiable Instruments Act, 1881	Lecture and case law discussion	Understanding various negotiable instruments available under the Act.
4	The Consumer Protection Act, 1986	Lecture and case law discussion	Understanding the rights and duties of consumers under the Consumer Protection Act
5	The Companies Act, 2013	Lecture and case law discussion	Understanding the requirements of forming a company under different categories and the importance of MOA, AOA and Prospectus.
6	Introduction to IPR Laws a) The Copy Right Act, 1957 b) The Patents Act, 1970 c) The Trade Marks Act, 1999	Lecture and case law discussion	Understanding the meaning and definition of intellectual property, types of intellectual property and the safeguards available through law against violation of intellectual property rights.
7	Indian Income-tax Act, The Finance Act	Lecture	Understanding the framework of Indian Income Tax Act with concepts of tax slabs, TDS, etc.
8	Computation of Total Income and Determination of Tax Liability – individuals and Companies	Conceptual discussion and practical problem solving	Ability to compute the income tax and tax liability of various assesses based on different cases.

Sr. No.	Content	Activity	Learning outcomes
9	Indirect Taxes – Central Excise Act	Lecture and case laws	Getting clarity on concepts of Indirect taxes, manufacturing, excisable goods, classification of goods, valuation of goods and CENVAT
10	Indirect Taxes – Customs Act	Lecture and case laws	Understanding the scope and coverage of Customs Act. Students should be clear about the types of customs duties and the classification and valuation of goods.
11	Indirect Taxes – Maharashtra Value Added Tax	Lecture and case laws	Understanding the difference between MVAT and State Sales tax and the tax slabs and exemptions in the Act.
12	Indirect Taxes – Service Tax	Lecture and case laws	Understanding the applicability of service tax and the tax slabs applicable.

Text Books

1	Legal Aspects of Business – AkhileshwarPathak
2	Students Guide to Income Tax – Monica singhania and VinodSinghania
3	Students Guide to Indirect Tax Laws – Monica Singhania and VinodSinghania

Reference Books

1	Legal Aspects of Business – David Albuquerque
2	Business Law for Managers – S.K. Tuteja
3	Business Law – N.D. Kapoor

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**II – Elective**			
Title of the Subject / course	**:**	**Cost and Management Accounting 100 Marks**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To understand the basic cost concepts and techniques of analyzing cost to have better management control and decision making

Prerequisites if any	
Connections with Subjects in the current or Future courses	This subject would provide basic understanding of cost and cost accounting which would help students in some of the advance subjects in all the disciplines in the second year

Module

Sr. No	Content	Activity	Learning outcomes
1	Introduction to Cost and Management Accounting Distinction and relationship among financial accounting, cost accounting and management accounting Role of Cost in decision making Analysis and classification of cost	Theoretical discussion	Understanding the concepts related to Financial, Cost and Management Accounting
2	Elements of cost - Materials, Labour and Overheads Allocation and apportionment of overheads	Discussion and Exercises	Understanding the difference between direct and indirect cost as well as apportionment and allocation of cost
3	Preparation of Cost Sheet	Exercises	Ability to prepare the cost sheet
4	Introduction to different costing techniques; Methods of costing – with special reference to job costing, process costing, services costing	Theoretical discussion and exercises	Understanding the computation methods of cost under various costing methods
5	Marginal Costing and Cost-Volume-Profit Analysis, Marginal costing versus absorption costing, Computation of breakeven point, margin of safety and P/V Ratio Differential Costing and Incremental Costing	Theoretical discussion and problem solving	Ability to make decisions using marginal cost concept and calculate BEP and Margin of safety
6	Budgeting and Budgetary Control Concept of budget, budgeting and budgetary control, Types of budget	Discussion and exercises	Ability to prepare various types of budgets and analyze the functional as well as the master budgets
7	Standard Costing and Variance Analysis	Discussion and exercises	Ability to set a benchmark and calculate and analyze variances
8	Responsibility Accounting and Transfer Pricing	Theoretical discussion	Understanding various responsibility centres and different transfer pricing methods for setting interdepartmental price

Sr. No	Content	Activity	Learning outcomes
9	Activity Based Costing & Activity Based Management	Discussion and exercises	Understanding the concepts and application of activity based costing
10	Target Costing	Discussion and exercises	Ability to calculate the selling price based on pre-determined targets
11	Lifecycle Costing	Discussion and exercises	Ability to calculate the cost of a product as it moves through the various phases of its life cycle
12	Environmental Costing	Discussion and exercises	Ability to trace the direct costs and allocate indirect costs to present information on social and environmental costs and benefits
13	Service Costing	Discussion and exercises	Ability to set up a cost sheet for service industry.

Text Books

1	Cost Accounting for Managerial Emphasis – Horngren, Datar, Foster
2	Management Accounting – Robert Kaplan, Anthony A. Atkinson
3	Cost and Management Accounting – Ravi. M. Kishore

Reference Books

1	Management Accounting for profit control – I. W. Keller, W. L. Ferrara
2	Accounting & Finance for Managers – T P Ghosh
3	Management Accounting – Paresh Shah – Oxford Publications
4	Cost Accounting – Jawaharlal and SeemaSrivastava
5	Management and Cost Accounting – Colin Drury

Assessment

Internal	40%
Semester end	60%

PROGRAMME :MMS

Semester	:	II			
Title of the Subject / course	:	**Business Environment**			
Course Code	:				
Credits	**:**	4	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To sensitize the students to the multi-faceted environment of business.
2	to enable them to appreciate the finer nuances of the environment, and,
3	to improve their ability to operate effectively in the contemporary globalized world as managers or entrepreneurs

Prerequisites if any	Nil
Connections with Subjects in the current or Future courses	1: It would also deal with macroeconomic issues, and, thus become an essential sequel to Managerial Economics dealing with microeconomics in Semester I, and, 2: it would be an essential pre-requisite to the University paper on Strategic Management in Semester III.

Module

Sr. No.	Content	Activity	Learning outcomes
1	Business environment - definition, nature and scope, distinction between internal and external environment of business, limitations of environmental analysis.	Lecture	The students should be able to decipher, analyse and understand the environment of business.
2	Socio-cultural environment of business: elements of culture, the impact of culture on business, multiculturalism	Lecture and a case study	The students should be able to decipher, analyse and understand the environment of business.
3	Political environment of business: The State and it's branches, political ideals including liberty, equality, fraternity and tolerance. The politics of coalition governments	Lecture and a case study	The students should be able to decipher, analyse and understand the environment of business.
4	Regulatory environment of business, including the need for effective regulation and governance as well as the ingredients of a good system of regulation	Lecture	The students should be able to decipher, analyse and understand the environment of business.
5	Regulatory environment of business, including the need for effective regulation and governance as well as the ingredients of a good system of regulation	Lecture	The students should be able to decipher, analyse and understand the environment of business.

6	Ecological issues and sustainable development	-- Do --	The students should be able to decipher, analyse and understand the environment of business.
7	National Income: Growth and development. Interconnectivity between macroeconomic variables & Business Cycles. The concept of Inclusive growth Subsidies, JAM (Jandhan, Aadhar and Mobile) and the "Make in India Campaign".	Lecture	Students should be able to understand the need for various campaigns and also the impact of changes in the various macroeconomic variables on economy as well as on business.
8	Money and Banking: including money supply, demand for money, credit creation.	Lecture	Students should be able to understand the need for various campaigns and also the impact of changes in the various macroeconomic variables on economy as well as on business
9	Central Banking and Monetary Policy: instruments of credit control, objectives of monetary policy. **Inflation: the concept**, demand pull, cost push inflation. Inflation & monetary policy	Lecture	Students should be able to understand the various instruments of credit control, and its impact on economy and business.
10	Budget, budgetary deficit, fiscal deficit and fiscal policy: aims, objectives and efficacy.	Lecture and a case study	Students will develop understanding about the Union Budget and its impact on the various sectors
11	The LPG model (Liberalisation, Privatization and Globalisation) : genesis, features, problems and prospects	Lecture	Students should develop an understanding of the opportunities & challenges of the policies relating to LPG with reference to business.
12	Balance of Payments. International trade blocks, IMF, IBRD, WTO.	Lecture	Students should develop a holistic understanding of the external sector as well as multilateral organization.
13	Presentations by students		Students should develop a holistic understanding of the external sector as well as multilateral organization

Text books

1	Economics by Paul Samuelson and Richard Nordhaus: Indian Adaptation, 19th edition
2	Indian Economy by Mishra and Puri
3	Macroeconomics for Management students by A. Nag

Reference books

1	Business Environment and Public Policy by R A Buchholz
2	Economic Survey by Ministry of Finance, Government of India - Different issues
3	World Development Report by the World Bank - different issues

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**II - Elective**			
Title of the Subject / course	**:**	**Ethos in Indian Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To sensitize students to Indian culture and value systems and the impact of this on management thinking and action
2	To increase the level of awareness of the thought leadership emanating from India and understand its relevance in modern times
3	To bring to focus importance of ethical and responsible behavior on the part of young managers

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	What is Indian Ethos ?	Prior study and group discussions	To understand the distinctive characteristics of the Indian ethos
2	Values	Deriving values from ancient scriptures	To understand the role of human values and professional values in our decisions and everyday life and business
3	Management of Self	Learning from ancient philosophies and spiritual wisdom	To have an awareness of ways for Anger management and Stress Management. To know the concepts of 'Total Quality of the Mind'.
4	Religion	To study the basic principles of different religions and their similarities. Case studies of modern day practices for diversity.	To know the basic tenets and historical roots of the religions followed by people in India. To know the meeting points/commonalities between religions. To appreciate diversity and pluralism in organizations and society
5	The concept of Dharma The concept of Karma	Study the traditional understanding of the concepts. Modern business Case studies revolving around these concepts	To know the meaning of corporate dharma and corporate karma. To understand the significance of Ethics as part of the Indian ethos.
6	Kautilya's Principles	Study the principles and find their modern relevance and application	To understand the relevance of Kautilya's principles in terms of the role of the leader in today's times

Sr. No.	Content	Activity	Learning outcomes
7	Leadership	Study the leadership and management preachings from the epics of Ramayana and Mahabharata	To understand the responsibilities of leadership
8	Social Responsibility, Sustainable Development Giving, Trusteeship concept of Mahatma Gandhi	Research on the traditional importance of 'Social Responsibility' Case studies on Sustainable Development	To understand the essence of the Trusteeship concept of Mahatma Gandhi. To understand modern day practices of sustainable development around the world.
9	The Constitution of India – Preamble of the Constitution, Fundamental Duties mentioned in Chapter IV A - Article 51 A	Discussion on current affairs / episodes and approach towards them	To understand and internalize the concepts and meanings of the core message in the Preamble and in the Fundamental Duties laid in the Constitution. To objectively and progressively analyze current issues, challenges and solutions affecting today's Indian society and Indian industry.

Text books

1	Management and the Indian Ethos by G. D. Sharma
2	Ethics, Indian Ethos and Management by S. Balachandran, K. C. R. Raja, B. K. Nair
3	Indian Ethos for Modern Management by G. R. Krishna
4	Indian Ethos and Values for Managers by N. M. Khandelwal

Reference books

1	Towards the optimal organizations (Indian Culture and Management) by Rayen Gupta
2	The seven spiritual Laws of Success by Deepak Chopra
3	Gandhi, CEO: 14 Principles to Guide & Inspire Modern Leaders by Alan Axelrod
4	My Experiments with Truth by M. K. Gandhi
5	The India Way by Peter Cappelli, Harbir Singh, Jitendra Singh and Michael Useem
6	Blending the best of the East and the West in Management education by SubhirChowdhury
7	India's contribution to Management: Pravir Malik (Sri Aurobinds Institute of Research in Social Sciences, pondicherry)
8	Vedic management by Krishna Saigal
9	Philosophies of Gandhi, Tagore and Kabir
10	Speeches by great Indians from history
11	Poems written by Rumi

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**II - Elective**			
Title of the Subject / course	**:**	**Corporate Social Responsibility**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	A fundamental assumption of Ethics & Social Responsibility is that organizations exists in uncertain, changing environment and continually confront new challenges and problems. Managers must find solutions to these concerns if organizations are to survive, prosper and perform effectively.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1.	Corporate Social Responsibility (CSR) – Meaning and Scope	**Case Study**	1. To have a good understanding of the different ways in which CSR can be managed effectively and integrated throughout an organization and acquire the practical skills to develop, manage and measure the impact of a CSR strategy. 2. Understand the ways in which CSR interventions can be planned, implemented, monitored and evaluated in an organization 3. Create an integrated approach to embed CSR within the core business and culture of an organization 4. Comprehend the ways in which CSR can make meaningful contribution to a sustainable culture within an organization
2.	CSR Models	**Case Study**	
3.	CSR and Business Ethics	**Case Study**	
4.	Role of Institutions in CSR	**Case Study**	
5.	Environmental Aspect of CSR: Environmental Issues for India and the world(Global Warming, Waste Disposal & Pollution) and CSR Efforts of Indian Companies for mitigation of these problems	**Case Study**	
6.	CSR and Corporate Sustainability: Introduction to Sustainability; Sustainability and its Challenges	**Case Study**	
7.	Global CSR	**Case Study**	
8.	Understanding Framework for Rating CSR: Global Reporting Initiatives, ISO 26000	**Case Study**	
9.	Project on CSR	**Case Study**	

Text books

1	MadhumitaChatterji, *Corporate Social Responsibility*, Oxford University Press.
2	Krishnamoorthy : *Environmental Management* (Prentice – Hall India)

Reference books

1.	Michael Blowfield and Alan Murray, *Corporate Responsibility*, Oxford University Press.

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**II - Elective**			
Title of the Subject / course	**:**	**Analysis of Financial Statements**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To understand the advanced tools used in financial statement analysis and financial reporting. Students should learn to do in-depth analysis of the performance of a company

Prerequisites if any	Financial Accounting and Financial Management
Connections with Subjects in the current or Future courses	This subject will form the base for many advanced subjects in finance in the second year

Module

Sr. No.	Content	Activity	Learning outcomes
1	Economy-Industry-Company Analysis Top-down and bottom up approach Different macro-economic variable Inflation rate Interest rates Commodities exchange rates and their impact on equity markets	Theoretical discussion	Understanding the macro factors affecting company's performance
2	Cash Flow Analysis Measuring operating / financing and investing cash flows Cash flows and life cycle state of a company Cash flows and financial flexibility (linkages to dividend policy and over retention of profits)	Theoretical discussion and problem solving	Ability to measure the financial health of a company using cash flow analysis
3	Assessing Business Performance Operational efficiency ratios (gross profit, net profit margins and various turnover ratios) Liquidity rations – current ratio, acid test ratio Profitability ratios, valuation ratios EPS/ROE/ROCE/Total shareholder returns, linkages between ROE & ROCE & optimal capital structure and determinants of PE multiple, price to book value, EV/EBDITA multiple. EVA, MVA	Theoretical discussion and problem solving	Ability to measure the financial health of a company using on ratio analysis

Sr. No.	Content	Activity	Learning outcomes
4	Industry Specific Ratios Analysis of Performance of a FMCG company Analysis of performance of an IT company Analysis of performance of a banks under CAMEL framework	Industry specific assignments and discussion	Ability to do the ratio analysis to measure the financial health of companies in specific industry sectors
5	Free Cash flows to Equity / Firm Capitalization leasing expense and R&D expenditure, correct treatment for amortization expense and deferred taxes Measuring correct ROE & ROC after adjusting for inter-corporate investments. Implication of the above mentioned adjustments on fundamental valuations / company and PE or Price / Book Value or EBDITA multiple.	Theoretical discussion and exercises	Understanding the mechanism of calculating cash flow and specific ratios after considering some special items in financial statements
6	Forecasting FCFE / FCFF and Security Valuation	Problem solving and discussion	Ability to calculate the intrinsic value of the firm using FCFF and FCFE models
7	Valuation of a Company Discounted cash flows Terminal value Equity value multiples		Understanding the concepts of company valuation based on DCF approach
8	Financial Modeling Key financial statements Working capital schedule Depreciation schedule, amortization schedule Long-term items schedule Building income statement, shooting, completing the financial models.	Lecture and exercises	Ability to create an integrated model for valuing a company based on different variables using MS-Excel
9	Valuation in Practice Valuation of a company in manufacturing sector Valuation of a company in service sector Valuation of a start-up company Valuation of e-commerce company Valuation of a conglomerate company	Company specific discussion and assignments	Understanding valuation concepts and techniques for different categories of companies
10	Pricing of Stock – Guiding for investment decision	Lecturing and exercises	Ability to calculate the intrinsic value and target market price of stock based on various models.

Text Books

1	Principles of Corporate Finance – Myers and Brealey
2	Financial Management – M. Y. Khan and P. K. Jain
3	Financial Management – Prasanna Chandra

Reference Books

1	Fundamentals of Financial Management – James Van Horne
2	Financial Management and Policy Managerial Finance – E. F. Brigham & J. F. Houston

Assessment

Internal	40%
Semester end	60%

PROGRAM : MMS

Semester	**:**	**I – Elective**			
Title of the Subject / course	**:**	**Entrepreneurship Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To acquaint the students with both the theory and practice of Entrepreneurship,
2	to expose the sudents to the finer nuances of the subject, and,
3	to re-orient the outlook of students towards new business ventures and start ups and also to help them to look at these as a possible career option.

Prerequisites if any	Nil
Connections with Subjects in the current or Future courses	1) Entrepreneurship Management would both supplement and complement the knowledge gained after doing papers like Businss Environment in the second semester, and, 2) 2) it would also pave the way for studying papers like Strategic Management (Semester III) and Project Management (Semester IV).

Module

Sr. No.	Content	Activity	Learning outcomes
1	**(A) Entrepreneurial Perspective** : • Concept of entrepreneur, entrepreneurship and enterprise, advantages of entrepreneurship • Nature and development of entreprener and entrepreneurship	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
2	• opportunity -based entrepreneurship • social entrepreneurship • entrepreneurship by Dalits • technopreneurship	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
3	Gender bias and women entrepreneurs	Lecture and a case study	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
4	Entrepreneurs, managers and intrapreneurs : similarities and differences	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
5	Innovation, creativity and entrepreneurship	Lecture and a case study	To gain an understanding of entrepreneurship, as well as to

Sr. No.	Content	Activity	Learning outcomes
			realise and harness the potential of new ventures and start ups.
6	(B**) The Entrepreneurial Environment**: • Analysis of business opportunities in both the domestic and global economies, including the analysis of PEST factors	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
7	• Quick-start routes to establish a business (franchising, ancillarising and asquisitioning) • Support organisations for an entrepreneur and their role	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
8	• Legal framework for starting a business in India • The Make in India Campaign, the Digital India Campaign and the opportunities for start ups in India	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
9	(C**) The Enterprise Launching :** • Product / Project identification • Preparing a Business Plan	Lecture and a case study	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
10	• Business financing, including venture capital finance and private equity	Lecture	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
11	• Managing early growth of business • New venture expansion - strategies and issues	Lecture and a case study	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
12	• International variations in entrepreneurship (including cultural and political differences) • Indian Family Business: genesis, features, issues and challenges	-- Do --	To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.
13	Presentations by students		To gain an understanding of entrepreneurship, as well as to realise and harness the potential of new ventures and start ups.

Text books

1	Entrepreneurship Management by P N Singh and J C Saboo.
2	Entrepreneurship by Rajeev Roy
3	Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepperd

Reference books

1	Beyond Entrepreneurship by James C Collins and William C Lazier
2	Dynamics of Entrepreneurial Development by Vasant Desai
3	Entrepreneurship Development in India by B Ghosh

Assessment

Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**II – Elective**			
Title of the Subject / course	**:**	**Management Information System**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives	
1	To understand the basic concept data and information , Framework / structure and role of Information and Information Systems for business
2	Determining Information Needs for an individual & Organization for decision making process.
3	To understand the requirement & analysis of MIS across the functions of the Management and Sectors of the industry and business
4	To emphasis the Information System Development Process and Security /Privacy of MIS

Prerequisites if any	Need & understanding of Management Information System
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Determining Information Needs for an Organization/Individual managers for decision making process

Module

S.no.	Content	Activity	Learning outcomes
1	Basic Information concepts and definitions Framework and role of Information and Information Systems(IS) in an organization, system concept Characteristics of Information and Organization with respect to organization form, structure , philosophy, hierarchy etc	Lecture	1. Role of Information system in various organization 2. Sector wise application of Information System 3. Role of Information System in analyzing as well as decision making process 4. To understand the application of MIS across the function and different industrial sector
2	Types of Information System (IS)- Transaction Processing System for Operational Control, Management Information System for Management Control, Decision Support System and , Executive Information Systems for Strategic Management, Knowledge Base Information System (Artificial Intelligent/ Expert System)	Lecture & cases	
3	Determining Information Needs for an Organization/Individual Manager, Overview of use of data and	Lecture	

	Information , analysis of information, Value of information for decision making and decision making processes etc		
4	MIS across the functions of the Management and Sectors i.e Marketing Information Systems Manufacturing Information Systems Human Resource Information Systems Financial Information Systems Information System Required across the Sectors.	Lecture and cases	
5	Strategic roles of IS Use of Information for Customer Bonding and Business Alliance Breaking Business Barriers –Business Processes Reengineering Improving Business Quality – Creating Virtual Company – Using Internet Strategically Building Knowledge and Creating Company – Challenges of Strategic of IS – Enterprise –wide systems and E- Business Applications for business & competitive advantages		
6	Managing information systems Enterprise Management Information Resource Management Technology Management IS planning methodologies – Critical Success factors Business Systems Planning – Computer Aided Planning Tools.		
7	Information System Development and Security Information System development Process and Models Sensitize students to the need for information security, Concepts such as confidentiality, Integrity and Availability, Types of threats and risk, overview of some of the manual, procedural and automated controls in real life IT environments. Computer Crime –Privacy Issues		
8	Case Studies and Presentations		

Text books	
1.	Management Information System- Managing the Digital Firm , by Laudon and Laudon
2.	Principal of Information System , by Ralph M. Stair and Georg Raynold

Reference books	
1.	O'Brien, James A Management Information Systems, Tata McGraw Hill, New Delhi,
2.	Marvin Gore, Elements of Systems Analysis & Design, ,Galgota Publications.
3.	MIS a Conceptual Framework by Davis and Olson
4.	Analysis and Design of Information Systems by James Senn
5.	Case Studies : Case on ABC Industrial Gases – Author : Prof PradeepPendse
6.	Jessup &Valacich: Information Systems Today (Prentice Hall India)
7.	Management Information Systems – M.Jaiswal&M.Mittal – Oxford Publications.

Assessment	
Internal	40%
Semester end	60%

PROGRAM: MMS

Semester	**:**	**II**			
Title of the Subject / course	**:**	**Developing Teams and Effective Leadership**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	Developing and managing a team
2	Understand how to adapt your leadership style to effectively lead and influence others
3	Strategies for coping with team challenges
4	Define your leadership philosophy and learn how to communicate it
5	Earning trust and building relationships
6	Leading virtual teams

Prerequisites if any	Base knowledge of Management and HRM
Connections with Subjects in the current or Future courses	Organizational Behaviour and Leadership Theories

Module

Sr. No.	Content	Activity	Learning outcomes
1	Team Building	Role play	Types of Teams and Team Building Stages
2	Role of leader in team development	Role play	Manage your team, your boss, and your colleagues more effectively
3	Art of using negotiations, power and influence	Case studies	Influencing others from a position of authority
4	Stress Management and Time Management	Case studies	Effective management of time and strategies to handle stress
5	Leading Virtual Teams	Videos, Case studies	Strategies for leading a virtual team

Text books

1	Management - Hellriegel, Slocum and Jackson
2	Leadership Theories - Composite
3	

Reference books

1	Leadership – Warren Bennis
2	Organizational Behaviour – Ashwathapa
3	Personnel management – ArunMonappa

Assessment

Internal	40% - Tests, Assignments
Semester end	60% - Exam

PROGRAM : MMS

Semester	**:**	**II - Elective**			
Title of the Subject / course	**:**	**Intellectual Capital and Patenting**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To ensure the fact that students of Business and Managerial Studies are aware of the concept and respect of Intellect and Intellectually driven properties.
2	To know and study about the concept and types of Intellectual Property Rights.
3	To understand and appreciate the need to honour and not infringe upon the Intellectual Property Right of others.
4	To inculcate in the minds of the young managers, entrepreneurs and professionals, the processes and patterns that are emerging in the field of Intellectual Property.
5	To encourage the business fraternity to develop new products, ideas, constructs and properties on a continual basis.
6	To study, understand and acknowledge the trends across the globe in areas of Patenting and Intellectual Property Rights especially in the areas where India is a major player viz. Information Technology, Media, Automobiles and Education.

Prerequisites if any	Suited better for students who have studies Sciences or Law till their Graduation level but it certainly isn't a limiting factor.
Connections with Subjects in the current or Future courses	1. Understanding Innovation 2. Management for Technology 3. Business Intelligence 4. Information Technology Governance and Compliance 5. Business-to-Business

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction to the concept of Intellect, Intellectual Property, Right, Duties and Intellectual Property Rights.	Class Room Discussions, Media Presentations	To appreciate the meaning of Intellectual Property
2, 3	Understanding of Philosophical and Legal Concept of Intellectual Property, Its importance, characteristics, features, impact.	Class Room Discussions, Case Studies, Media Presentations.	Understanding of the philosophical, ideological and Legal framework as used in the context of Intellectual Property.
4	The Economics behind Intellectual Property and Intellectual Property Rights.	Class Room Discussions, Case Studies, Media Presentations.	The relationship between Business and Intellectual Property Right and to appreciate the fact that the outlay incurred on protection of Intellectual Property isn't a Cost but an Investment for the Business
5, 6,	Types of Intellectual	Class Room	Understanding the actual scope and

Sr. No.	Content	Activity	Learning outcomes
7, 8	Property, namely, Trade Marks, Geographical Indications, Copyright, Industrial Design. Their respective definitions, characteristics, importance, scope, registration, infringement and protection. Indian Laws related to IPR.	Discussions, Case Studies, Media Presentations, real life case laws, judicial interpretations. Seminars, talks by legal experts should be encouraged at this stage to understand the statutory compulsions of Intellectual Property Rights.	extent of Intellectual Property. Their connection with Business and the need to protect them to ensure a congenial Business environment.
9, 10,11	Patent : Definition, Importance, Development, Type, Features and Essentials. Process of Registration, infringements : types, Protection. Licensing process : Software Licensing, General Licensing, Compulsory Licensing. Indian Laws related to Patent.	Class Room Discussions, Case Studies, Media Presentations, real life case laws, judicial interpretations. Seminars, talks by legal experts should be encouraged at this stage to understand the statutory compulsions of Intellectual Property Rights. Also, have representatives of Organisations, R & D experts who have developed worked on Patents in particular and Intellectual Property Rights sphere in general.	Understanding the actual scope and extent of Intellectual Property. Their connection with Business and the need to protect them to ensure a congenial Business environment.
12	International Protocols, Conventions, Trends and Scenario of Intellectual Property Rights. TRIPS, GATT etc.	Class Room Discussions, Case Studies, Media Presentations.	Appreciating and Understanding the Global view of IPR
13	IP Management, Concept of IP Management, Intellectual Property and Marketing, IP asset valuation	Class Room Discussions, Case Studies, Media Presentations.	Management and Intellectual Property. Monetisation and Evaluating IP.

Text books

1	Indian Patents Act, Indian Copyright Act, Indian Trademarks Act, Indian Designs Act.
2	TRIPS Agreement
3	Cornish : Intellectual Property.

Reference books

1	Nair and Kumar : Intellectual Property Rights.
2	Narayanan : Patent Law
3	Saxena : Trade Related Issues of Intellectual Property Rights and Indian Patents Act.

Assessment

Internal	40%
Semester end	60%

MMS Revised Guidelines under Credit Based Semester and Grading System:
(10 point grading system)

EXAMINATION / ASSESSMENT AND GRADING

Semester wise performance assessment of every registered learner is to be carried out through various modes of examinations. These include Internal Assessment and End Semester Examination. Internal Assessment includes class tests, home assignments based on live problems, course projects either in a group or individually. The modes of evaluation and distribution of weightage for each of the assessments is given in the syllabus manual of the programme. Normally weightage of Internal Assessment and End Semester Examination is 40 and 60 percentage respectively.

Mode of Assessment/Evaluation

Mode of Evaluation for Theory Course:-

The various modes of assessment used for rating learners' performance in a theory course include

1. Internal Assessment and End Semester Examination. Relative weightage for Internal Assessment is typically 40 percent and will be evaluated by the faculty as per his/her Teaching Learning Plan submitted at the beginning of the academic year.
2. The end semester examination will be held at the end of the Semester planned by the Institute and the relative weightage for this would be 60 percent. It is normally of 3 hours duration and will cover the full syllabus of the course. **The end semester examination is mandatory.** The **grade** for **theory courses** can be **awarded** only after **successful completion** of both **Internal Assessment** and **End Semester Examination** of the respective course.

Mode of Evaluation of Projects

If the performance of a student is to be evaluated through Project work for any course since for a subject like "Creativity & Innovation" the Internal Examination OR End Term Examination (written) may not be suitable method of evaluation then the project evaluation to be done as per the following guidelines keeping the ratio of Internal and End term Examination intact to 40 and 60 respectively.

The learner (individual / Group) to be given a **Project** – (Problem or a situation) for which he needs to Prepare the solution. This Project is to be graded, at the end of the respective semester. The projects are supervised or guided, and need regular interaction (atleast once a week) with the mentor/guide. Project group has to submit a project report and defend it in front of a panel of examiners. Panel of examiners for Project evaluation will be appointed by Head of Department/Institute. The project report will not be accepted if students fail to complete the project successfully and submit on or before the deadline given for the project submission.. The **grade** for **Project** can be awarded only after **successful completion** of **Term Work** and **Oral Presentation / viva-voce** as per the schedule.

For Example, if a faculty wants to evaluate the learners' performance through a project for 100 marks. He can devise the marks allocation as 40 marks for "the conceptual understanding of the Topic, Introduction and methodology he wishes to adopt and 60 marks for the actual data collected, usage of methodology he thought of , preparation and presentation of the report with conclusions and presentation to the panelists.

Another example is a subject, "Developing Teams and Effective Leadership". These skills should be learnt by doing rather than by learning theory and writing examination. Therefore, an institute offering this subject may evolve a suitable method of evaluation and break it into internal and end semester evaluation.

Grading of Performance

Letter Grade and Grade Point Allocation

The Revised Credit and Grading System will be effective from the academic year 2016-2017 for the Faculty of Management of University of Mumbai. In every Course, based on the combined performance in all assessments, in a particular Semester as per the curriculum/syllabus, the student is awarded a letter grade. These letter grades not only indicate a qualitative assessment of the learner's performance but also carry a quantitative (numeric) equivalent called the Grade Point. The letter grades and their equivalent grade point applicable for **MMS** program are given below:

A learner who remains **absent** in any form of **evaluation/examination, letter grade** allocated to him/her should be **AB** and corresponding **grade point** is **zero.** He/She should reappear for the said evaluation/examination in due course.

Range of percentage of Marks	Letter Grade	Grade Point	Performance	SGPA / CGPA Range
80 and above	O	10	Outstanding	9.51 – 10
75-79.99	A+	9	Excellent	8.51 – 9.50
70-74.99	A	8	Very Good	7.51 – 8.50
65-69.99	B+	7	Good	6.51 – 7.50
60-64.99	B	6	Fair	5.51 – 6.50
55-59.99	C	5	Average	4.51 – 5.50
50-54.99	P	4	Pass	4.0 – 4.50
Below 50	F	0	Fail	< 4
Absent	AB	0	Fail	

SGPA/ CGPA Calculation

Semester Grade Point Average (SGPA)

The performance of a learner in a semester is indicated by a number called Semester Grade Point Average (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the learner during the Semester. For example, if a learner passes five courses (Theory/Projects etc.) in a semester with credits C_1, C_2, C_3, C_4 and C_5 and learners grade points in these courses are G_1, G_2, G_3, G_4 and G_5 respectively, then learners' SGPA is equal to:

$$\textbf{SGPA} = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The SGPA is calculated to two decimal places. The SGPA for any semester will take into consideration the "***F*** or ***AB***" grade awarded in that semester. For example if a learner has failed in course 4, the SGPA will then be computed as:

$$\textbf{SGPA} = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4\text{*ZERO} + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

Cumulative Grade Point Average (CGPA)

An up to date assessment of the overall performance of a learner from the time s/he entered the University of Mumbai is obtained by calculating a number called the Cumulative Grade Point Average (CGPA), in a manner similar to the calculation of SGPA. The CGPA therefore

considers all the courses mentioned in the curriculum/syllabus manual, towards the minimum requirement of the degree learner have enrolled for. The CGPA is calculated at the end of every semester to two decimal places and is indicated in semester grade report cards.The CGPA will reflect the **failed status** in case of **F grade(s),** till the course(s) is/are **passed**. When the **course(s)** is/are **passed** by obtaining a **pass grade** on subsequent examination(s) the **CGPA** will only reflect the **new grade** and not the **fail grades** earned earlier.

Example: Up to semester ***r*** a learner has registered for ***n*** courses, among which s/he has "***F***" grade in i^{th} course. The semester grade report at the end of semester ***r*** therefore will contain a CGPA calculated as:

$$\textbf{CGPA} = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots C_i{*}ZERO + \ldots + C_nG_n}{C_1 + C_2 + C_3\ldots + C_{i+} \ldots + C_n}$$

Even if a learner has **failed** in a course **more than once,** the course will figure **only once** in the **numerator** as well as the **denominator**. At the end of semester ***r+1*** s/he has appeared for examination for ***k*** number of courses including the i^{th} **backlog course** and has cleared all the courses including the **backlog course,** the CGPI at the end of this semester is calculated as,

$$\textbf{CGPA} = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots C_i{*}G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3\ldots + C_{i+} \ldots + C_n}$$

There will also be **a final CGPA** calculated which considers **all the credits earned** by the learner specified for a particular programme.

Illustration of Computation of SGPA and CGPA

Computation of SGPA and CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = Σ(Ci x Gi) / ΣCi

where Ci is the number of credits of the *i*th course and

Gi is the grade point scored by the student in the *i*th course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = $\Sigma(Ci \times Si) / \Sigma Ci$

where Si is the SGPA of the *i*th semester and

Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts. A Successful learner who has passed in all the courses of each Semesters i.e Semester I, Semester II, Semester III and Semester IV shall be awarded grades as shown in the table given below:

Grade Table: - Grade Allocation under 10 point grading scale in CBSGS.

Range of percentage of Marks	Letter Grade	Grade Point	Performance	SGPA / CGPA Range
80 and above	O	10	Outstanding	9.51 – 10
75-79.99	A+	9	Excellent	8.51 – 9.50
70-74.99	A	8	Very Good	7.51 – 8.50
65-69.99	B+	7	Good	6.51 – 7.50
60-64.99	B	6	Fair	5.51 – 6.50
55-59.99	C	5	Average	4.51 – 5.50
50-54.99	P	4	Pass	4.0 – 4.50
Below 50	F	0	Fail	< 4
Absent	AB	0	Fail	

Example to illustrate the computation of SGPA and CGPA

Semester I

Subject	**Marks**	**Grade**	**Grade Point (Gi)**	**Credits (Ci)**	**Ci*Gi**	**SGPA**
Sub-1	95	O	10	4	40	SGPA = 108/16 = 6.75
Sub-2	59	C	5	4	20	
Sub-3	59	C	5	4	20	
Sub-4	68	B+	7	4	28	
Credits Earned				**16**	**108**	
Remarks:					**Grade: B+**	Range 65-69.99

Semester II

Subject	**Marks**	**Grade**	**Grade Point (Gi)**	**Credits (Ci)**	**Ci*Gi**	**SGPA**
Sub-1	60	B	6	4	24	SGPA= 120/16 = 7.50
Sub-2	65	B+	7	4	28	
Sub-3	66	B+	7	4	28	
Sub-4	80	O	10	4	40	
Credits Earned				**16**	**120**	
Remarks: Successful					**Grade: B+**	Range65-69.99

Semester III

Subject	**Marks**	**Grade**	**Grade Point (Gi)**	**Credits (Ci)**	**Ci*Gi**	**SGPA**
Sub-1	62	B	6	4	24	SGPA = 128/16 = 8.00
Sub-2	68	B+	7	4	28	
Sub-3	85	O	10	4	40	
Sub-4	78	A+	9	4	36	
Credits Earned				**16**	**128**	
Remarks: Successful					**Grade: A**	range 70-74.99

Semester IV

Subject	Marks	Grade	Grade Point (Gi)	Credits (Ci)	Ci*Gi	SGPA
Sub-1	89	O	10	4	40	SGPA = 96/12 = 8.00
Sub-2	63	B	6	4	24	
Sub-3	72	A	8	4	32	
Credits Earned				**12**	**96**	
Remarks: Successful					**Grade: A**	range 70-74.99

Calculation of CGPA

Semester	SGPA (Si)	Credits (Ci)	Si*Ci	CGPA	
I	6.75	16	108	CGPA= 452/60 = 7.53	**Grade: A**
II	7.5	16	120		
III	8	16	128		
IV	8	12	96		
Total Credits Earned		**60**	**452**		range70-74.99

Heads of Passing

Internal Assessment (IA) and End Semester Examination (ESE) should be two separate heads for passing. E.g. 40 marks (IA), 60 marks (ESE). Passing standard will be 50% in each individually, i.e 20 marks in (IA) and 30 marks in ESE.

3.6 Promotion of Learner and Award of Grades

A learner will be declared **PASS** and be eligible for **Grade** in M.M.S. course (**Post Graduate Programme**) if a learner secures **at least 50% marks separately in each head of passing as** mentioned above.

Report Card will contain only Grades and no numerical marks.

At the end of each Semester the Grade card which states the performance of the learner in that Semester, is prepared and issued to the leaner. The Grade Card will contain the courses undertaken by the learner, credits of each course, Grade obtained by the learner and SGPA / CGPA in the format given by the University.

Carry Forward of Marks

In case of a learner who does not fulfill criteria mentioned in section 3.4 and fails in the **Internal**

Assessment and/or **End Semester Examination** in one or more courses:

- A learner who **PASSES** in the **Internal Assessment** but **FAILS** in the **End Semester Examination** of the course shall reappear for the **End Semester Examination** of that course. However his/her marks of the **Internal Assessment** shall be **carried over** and he/she shall be entitled for grade obtained by him/her on passing.
- A learner who **PASSES** in the **End Semester Examination** but **FAILS** in the **Internal Assessment** of the course shall **reappear** for the **Internal Assessment** of that course. However his/her marks of the **End Semester Examination** shall be **carried over** and he/she shall be entitled for grade obtained by him/her on passing.

Re-examination of Internal Assessment and End Semester Examination

Re-examination for **Internal Assessment and End Semester Examination** should be completed, as per the schedule planned by the respective institutes, before the commencement of next semester theory examination.

Example: A learner who is supposed to reappear for ***Internal Assessment or End Semester Examination*** in semester-I course will appear for the re-examination before commencement of End Semester Examination of semester -II. However, if a learner has to appear for the re-examination for a subject in semester II then the examination should be conducted and the result should declared by the institute before the examination forms for the semester III are sent to the University.

Re-examination of Internal Assessment will be based on single examination having same marks as of original assessment. A learner who supposed to reappear for Internal Assessment will be given some work by the concerned teacher. The work assigned can be of the form of a course project/ assignment problems/ test/ tutorials etc. A learner will do the submission of the assigned work in the predefined period. Records should be maintained properly for all the re-examinations as well as Internal Assessments.

Rules for Standard of Passing and Allowed to Keep Terms (ATKT)

1. Under the newly introduced credit based grading system of MMS programme, a learner in order to pass has to obtain minimum 50% marks in aggregate consisting of minimum 50% marks in each set of the examinations separately i.e. internal examination and external examination, as per the standard of passing.
2. Learner(s), who do not obtain minimum 50% marks in subject(s)/paper(s)/course(s) either in the internal assessment or in the external examination or both, shall be declared as "Fail" as per the standard of passing of examination.
3. A learner failing in not more than two subjects/papers/courses in the Semester I exam shall be allowed to keep terms in Semester II of the MMS programme.
4. A learner who has failed in more than two subjects/papers/courses in the Semester I exam, shall not be permitted to proceed to Semester II of his/her first year MMS programme. He/ She will, however, be eligible to re – appear for the subjects in which he /she has failed in the first semester by re – registering himself/herself in the supplementary examination to be conducted by the institute.
5. A learner who has passed in both the semester examinations conducted by the institute i.e.: Semester I and Semester II examinations shall be eligible for admission into Semester III of the MMS programme.
6. A learner failing in not more than two subjects/papers/courses in the Semester III examination shall be allowed to keep terms in Semester IV of the MMS programme.
7. A learner, who has failed in more than two subjects/papers/courses in Semester III, shall not be permitted to proceed to Semester IV of his/her second year MMS programme. He/She will, however, be eligible to re – appear in the subjects in which he /she has failed in the third semester by re – registering himself/herself in the supplementary examination to be conducted by the institute/university or both.

8. A learner who has passed in all of the semester examinations of MMS i.e Semester I, Semester II, Semester III, Semester IV examinations shall not be allowed to re – register himself/herself for improvement of his/her semester examination results.
9. A learner who has not appeared in the internal examinations conducted by the institute for due to hospitalization shall as a special case be permitted to appear in those subject(s)/course(s)/paper(s) in the supplementary examination conducted by the institute after he/she furnishes a valid medical certificate certified by the rank of a civil surgeon or superintendent of Government hospital to the satisfaction of the Principal/Director of the institute.

SEMESTER EXAMINATIONS

The MMS degree programme under the new credit based grading system shall be of two years duration consisting of Four (04) Semesters. The semester examinations for the Master of Management Studies will be held at the end of every semester i.e at the end of Semester I, Semester II, Semester III and Semester IV. The Semester I examination will be held in the Second half of the academic year in which the learner was admitted (i.e November/December), Semester II examination will be held in the first half of the calendar year (April/May), The Semester III examination will be held in the Second half of the academic year (i.e November/December), Semester IV examination will be held in the first half of the calendar year (April/May) respectively.

UNIVERSITY OF MUMBAI

Restructured & Revised Syllabus under

Credit based Semester and Grading System

for

Master of Management Studies (MMS)
Semester III & IV

2 Years full-time
Masters Degree Course in Management

(Effective from the academic year 2016 – 2017)

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester III

Sr. No.	Common subjects
1	International Business
2	Strategic Management (UA)

FINANCE SPECIALIZATION

Sr. No.	Core	Sr. No.	Electives (Any 1)
1	Financial Markets and Institutions	1	Banking and Financial Services Institutions
2	Corporate Valuation and Mergers & Acquisitions	2	Investment Banking
3	Security Analysis and Portfolio Management	3	Wealth Management
4	Financial Regulations	4	Infra and Project Finance
5	Derivatives and Risk Management	5	Strategic Cost Management
	Summer Internship	6	Commodities Markets
		7	Mutual Fund
		8	Financial Modeling
		9	International Finance

SYSTEMS SPECIALIZATION

Sr. No.	Core	Sr. No.	Electives (Any 1)
1	Database Management System & Data Warehousing	1	Cloud Computing & Virtualization
2	Enterprise Management System	2	Information System Security and Audit
3	Big Data and Business Analytics	3	Data Mining and Business Intelligence
4	Knowledge Management	4	IT Consulting
5	Software Engineering	5	Digital Business
	Summer Internship	6	Software Project management
		7	Governance of Enterprise IT & Compliance
		8	Cyber Laws & Managing Enterprise IT Risk

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester III

Sr. No.	Common subjects
1	International Business
2	Strategic Management (UA)

HRM SPECIALIZATION

Sr. No.	Core	Sr. No.	Electives (Any 1)
1	Training & Development	1	Personal Growth Laboratory
2	Compensation and Benefits	2	Global HRM
3	Competency Based HRM and Performance Management	3	Employee Branding and Employer Value Proposition
4	Labour Laws and Implications on Industrial Relations	4	HR Analytics
5	HR Planning and Application of Technology in HR	5	O.S.T.D.
	Summer Internship	6	HR Audit
		7	Employee Relations , Labour Laws and Alternate Dispute Resolution

OPERATIONS SPECIALIZATION

Sr. No.	Core	Sr. No.	Electives (Any 1)
1	Supply Chain Management	1	World Class Manufacturing
2	Operations Analytics	2	Business Process Re-engineering And Benchmarking
3	Service Operations Management	3	Technology Management & Manufacturing Strategy
4	Manufacturing Resource Planning & Control	4	Strategic Operations Management
5	Materials Management	5	Industrial Engineering Applications & Management
	Summer Internship	6	TQM
		7	International Logistics
		8	Quantitative Models in Operations
		9	Productivity Management

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester III

Sr. No.	Common subjects
1	International Business
2	Strategic Management (UA)

MARKETING SPECIALIZATION

Sr. No.	Core	Sr. No.	Electives (Any 1)
1	Sales Management	1	Retail Management
2	Marketing Strategy	2	Rural Marketing
3	Consumer Behaviour	3	Marketing Analytics
4	Services Marketing	4	Digital Marketing
5	Product & Brand Management	5	Customer Relationship Management
	Summer Internship	6	Marketing Research & Analysis
		7	Event Management
		8	Health Care Marketing
		9	Distribution & SCM
		10	Tourism Marketing
		11	Marketing of Banking & Financial Services

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

FINANCE

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	International Business	27	2	40 IA	60 IA	100	3	4
2	Strategic Management (UA)	27	2	40 IA	60 UA	100	3	4
3	Financial Markets and Institutions	27	2	40 IA	60 IA	100	3	4
4	Corporate Valuation and Mergers & Acquisitions	27	2	40 IA	60 IA	100	3	4
5	Security Analysis and Portfolio Management	27	2	40 IA	60 IA	100	3	4
6	Financial Regulations	27	2	40 IA	60 IA	100	3	4
7	Derivatives and Risk Management	27	2	40 IA	60 IA	100	3	4
8	**Summer Internship**	-	-	-	-	100	-	4

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

FINANCE

1 ELECTIVES OUT OF 9								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Banking and Financial Services Institutions	27	2	40 IA	60 IA	100	3	4
2	Investment Banking	27	2	40 IA	60 IA	100	3	4
3	Wealth Management	27	2	40 IA	60 IA	100	3	4
4	Infra and Project Finance	27	2	40 IA	60 IA	100	3	4
5	Strategic Cost Management	27	2	40 IA	60 IA	100	3	4
6	Commodities Markets	27	2	40 IA	60 IA	100	3	4
7	Mutual Fund	27	2	40 IA	60 IA	100	3	4
8	Financial Modeling	27	2	40 IA	60 IA	100	3	4
9	International Finance	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**36**

UA: University Assessment **IA: Internal Assessment**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

SYSTEMS

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	International Business	27	2	40 IA	60 IA	100	3	4
2	Strategic Management (UA)	27	2	40 IA	60 UA	100	3	4
3	Database Management System & Data Warehousing	27	2	40 IA	60 IA	100	3	4
4	Enterprise Management System	27	2	40 IA	60 IA	100	3	4
5	Big Data and Business Analytics	27	2	40 IA	60 IA	100	3	4
6	Knowledge Management	27	2	40 IA	60 IA	100	3	4
7	Software Engineering	27	2	40 IA	60 IA	100	3	4
8	**Summer Internship**	-	-	-	-	100	-	4

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

SYSTEMS

1 ELECTIVES OUT OF 8								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Cloud Computing & Virtualization	27	2	40 IA	60 IA	100	3	4
2	Information System Security and Audit	27	2	40 IA	60 IA	100	3	4
3	Data Mining and Business Intelligence	27	2	40 IA	60 IA	100	3	4
4	IT Consulting	27	2	40 IA	60 IA	100	3	4
5	Digital Business	27	2	40 IA	60 IA	100	3	4
6	Software Project management	27	2	40 IA	60 IA	100	3	4
7	Governance of Enterprise IT & Compliance	27	2	40 IA	60 IA	100	3	4
8	Cyber Laws & Managing Enterprise IT Risk	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**36**

UA: University Assessment **IA: Internal Assessment**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

HRM

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	International Business	27	2	40 IA	60 IA	100	3	4
2	Strategic Management (UA)	27	2	40 IA	60 UA	100	3	4
3	Training & Development	27	2	40 IA	60 IA	100	3	4
4	Compensation and Benefits	27	2	40 IA	60 IA	100	3	4
5	Competency Based HRM and Performance Management	27	2	40 IA	60 IA	100	3	4
6	Labour Laws and Implications on Industrial Relations	27	2	40 IA	60 IA	100	3	4
7	HR Planning and Application of Technology in HR	27	2	40 IA	60 IA	100	3	4
8	**Summer Internship**	-	-	-	-	100	-	4

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

HRM

1 ELECTIVES OUT OF 7								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Personal Growth Laboratory	27	2	40 IA	60 IA	100	3	4
2	Global HRM	27	2	40 IA	60 IA	100	3	4
3	Employee Branding and Employer Value Proposition	27	2	40 IA	60 IA	100	3	4
4	HR Analytics	27	2	40 IA	60 IA	100	3	4
5	O.S.T.D.	27	2	40 IA	60 IA	100	3	4
6	HR Audit	27	2	40 IA	60 IA	100	3	4
7	Employee Relations , Labour Laws and Alternate Dispute Resolution	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**36**

UA: University Assessment **IA: Internal Assessment**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
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OPERATIONS

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	International Business	27	2	40 IA	60 IA	100	3	4
2	Strategic Management (UA)	27	2	40 IA	60 UA	100	3	4
3	Supply Chain Management	27	2	40 IA	60 IA	100	3	4
4	Operations Analytics	27	2	40 IA	60 IA	100	3	4
5	Service Operations Management	27	2	40 IA	60 IA	100	3	4
6	Manufacturing Resource Planning & Control	27	2	40 IA	60 IA	100	3	4
7	Materials Management	27	2	40 IA	60 IA	100	3	4
8	**Summer Internship**	-	-	-	-	100	-	4

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

OPERATIONS

1 ELECTIVES OUT OF 9								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	World Class Manufacturing	27	2	40 IA	60 IA	100	3	4
2	Business Process Re-Engineering And Benchmarking	27	2	40 IA	60 IA	100	3	4
3	Technology Management & Manufacturing Strategy	27	2	40 IA	60 IA	100	3	4
4	Strategic Operations Management	27	2	40 IA	60 IA	100	3	4
5	Industrial Engineering Applications & Management	27	2	40 IA	60 IA	100	3	4
6	TQM	27	2	40 IA	60 IA	100	3	4
7	International Logistics	27	2	40 IA	60 IA	100	3	4
8	Quantitative Models in Operations	27	2	40 IA	60 IA	100	3	4
9	Productivity Management	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**36**

UA: University Assessment **IA: Internal Assessment**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

MRKETING

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	International Business	27	2	40 IA	60 IA	100	3	4
2	Strategic Management (UA)	27	2	40 IA	60 UA	100	3	4
3	Sales Management	27	2	40 IA	60 IA	100	3	4
4	Marketing Strategy	27	2	40 IA	60 IA	100	3	4
5	Consumer Behaviour	27	2	40 IA	60 IA	100	3	4
6	Services Marketing	27	2	40 IA	60 IA	100	3	4
7	Product & Brand Management	27	2	40 IA	60 IA	100	3	4
8	**Summer Internship**	-	-	-	-	100	-	4

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER III (CBGS)
With effect from Academic year 2016-17

MRKETING

1 ELECTIVES OUT OF 11								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Retail Management	27	2	40 IA	60 IA	100	3	4
2	Rural Marketing	27	2	40 IA	60 IA	100	3	4
3	Marketing Analytics	27	2	40 IA	60 IA	100	3	4
4	Digital Marketing	27	2	40 IA	60 IA	100	3	4
5	Customer Relationship Management	27	2	40 IA	60 IA	100	3	4
6	Marketing Research & Analysis	27	2	40 IA	60 IA	100	3	4
7	Event Management	27	2	40 IA	60 IA	100	3	4
8	Health Care Marketing	27	2	40 IA	60 IA	100	3	4
9	Distribution & SCM	27	2	40 IA	60 IA	100	3	4
10	Tourism Marketing	27	2	40 IA	60 IA	100	3	4
11	Marketing of Banking & Financial Services	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**36**

UA: University Assessment **IA: Internal Assessment**

Programme - Masters in Management Studies

Semester - III

COMMON SUBJECT

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**International Business**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1.	To develop a deep understanding of International Management
2.	To develop the analytical ability of the student to attain an insight into International Management contexts

Prerequisites if any	Business Management
Connection with subjects in the current or future courses	International Marketing Strategic Management

Module

Sr. No.	Content	Activity	Learning Outcome
1.	Introduction ➢ Objective ➢ Scope ➢ Perlmutter's EPRG Model	**Lecture**	Understanding the scope of international business
2.	Country Analysis ➢ PESTEL analysis ➢ The Atlas of Economic Complexity ➢ Porters Diamond ➢ Country Risk analysis	**http://atlas.cid.harvard.edu Activity on PESTEL of emerging markets Lecture**	Evaluating country attractiveness, impact on business models
3.	Cross Cultural Management ➢ Hofstede's Cultural Dimension ➢ CAGE Framework Pankaj Ghemawat ➢ Culture and Leader Effectiveness: The GLOBE Study	**Case/ lecture**	Understanding cultural differences and impact on business operations
4.	Mode of Entry ➢ Market/Country Entry Strategic Alliances/- JV / M&A	**Case / lecture**	Optimal way to enter a market

Sr. No.	Content	Activity	Learning Outcome
5.	Investment Decisions ➢ Drivers of FDI – Special emphasis on emerging markets ➢ Offshore Banking ➢ Forex Management – ADR-GDR's- EU bonds	**Case / lecture**	International finance decisions and impact on operations
6.	WTO Regional Trade Agreements ➢ Building Blocks of WTO ➢ Major agreements of WTO	**Case / lecture**	Basics of WTO from the perspective of a business manager
7	Managing of Multinationals ➢ Organization Structure -Matrix -Geographic -Product ➢ International HRM -Expatriate Management -Staffing of Subsidiaries ➢ Integration Response Models -Types of subsidiaries -Control of subsidiaries ➢ Global manufacturing and supply chain - Optimizing of Supply chain - Offshoring V/S Outsourcing	**Cases / Lectures/Assignment**	Multinational and subsidiary development and management. Impact of I-R model on subsidiary management.

Text Books

1) International Business - Mike W. Peng; Klaus E. Meyer - Cengage Learning
2) International Business Environment, The: Text and Cases- J Stewart Black ; Anant K Sundaram – Prentice Hall India
3) International Business –Charles W L Hill - McGraw Hill

Reference Books

1. International Management - Arvind V Pathak - TMH
2. The Cultural Dimension of International Business – Gary P Ferraro – Pearson
3. Multinational Management – John B. Cullen _ Thomson
4. International Business: Challenges and Choices - Alan Sitkin, Nick Bowen – Oxford Press

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Strategic Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objective

1	To appreciate the role of Strategic thinking in changing business environment
2	To understand the process of Strategy Formulation, Implementation & Evaluation
3	Focus on application & decision making

Prerequisites if any	
Students to refresh themselves on critical concepts and models in the areas of wrt HR, Marketing, Finance, Operations	The subject provides knowledge about corporate level strategies with cross functional perspective. Hence basic orientation of all relevant business disciplines is appreciated

Module

Sr. No	Content	Activity	Learning outcomes
1	Introduction to Strategic Management and schools of Strategic formulation and implementation & evaluation	Lecture and Case discussion	Familiarization with terminologies and processes of Strategic Management
2	Globalization, addressing a VUCA environment with a bottoms – up approach (Volatile, Uncertain, Complex and Ambiguous time)	Lecture and Case discussion	Understanding of Strategic Management so as to enable the students shoulder responsibilities in the ever changing global arena
3	PESTEL & SWOT as tools for strategic formulation	Lecture and Case discussion	Environmental scanning and appreciation of external business environment for effective strategy formulation
4	BCG matrix / GE matrix, 7S McKinsey models as tools for strategic formulation	Lecture and Case discussion	SBU portfolio management and strategic coherence
5	Ansoff matrix, Grand strategy as tools for strategic formulation	Lecture and Case discussion	Acquaintance with tools of strategic fit
6	Porter's Generic strategies and Value chain	Lecture and Case discussion	Understanding industry analysis and sustainable competitive advantage
7	Internal Competences & Resources Core, Distinctive, Strategic & Threshold Competence, Competence vs Capability, Resource Analysis , Value Chain Analysis, Strategic Outsourcing Core competence and synergy,	Lecture and Case discussion	Leveraging Sustainable unique advantage with path dependence

Sr. No	Content	Activity	Learning outcomes
	Distinctive competencies, VRIO analysis		
8	Red – Blue - Purple Ocean strategy	Lecture and Case discussion	Identifying strategic gaps in the market and filling them with unique advantage
9	Competing in Global Markets: Differences in Cultural, Demographic and Markets, Multi Country and Global competition concepts, Strategy options Competing in Emerging Markets	Lecture and Case discussion	Understanding organizational growth options, strategizing and implementing them
10	Mergers and Acquisitions, Strategic alliance & Joint Ventures, Vertical Integration, Offensive , Defensive Strategies,	Lecture and Case discussion	Understanding non- financial perspective and strategic parameters in the globalized world
11	Strategy Evaluation and Control Types of Control, Evaluation & Control Criteria Pre & Post Implementation	Lecture and Case discussion	Understanding of evaluation and control processes to ensure effective implementation
12	Change management and Turn – around strategies	Lecture and Case discussion	Multi directional, innovative ways of business growth, aligning organizational forces to achieve desired objectives
13	Case studies & presentation		

Texts Books

1. Pierce & Robinson, "Strategic Management: Formulation, Implementation & Control", 9th Ed, Tata McGraw – Hill, N. Delhi
2. David Fred R, "Strategic Management: Concepts & Cases", 10th Ed, Pearson – Prentice Hall, N. Delhi
3. Thomson, Strickland, Gamble & Jain, "Crafting & Executing Strategy", 14th Ed, Tata McGraw – Hill, N.Delhi
4. Hit, Ireland, Hoskisson & Manikutty, "Strategic Management: A South – Asian Perspective", 9th Ed, Cengage Learning, Delhi

Reference Books:

1. Pierce & Robinson, "Strategic Management: Formulation, Implementation & Control", 9th Ed, Tata McGraw – Hill, N. Delhi
2. David Fred R, "Strategic Management: Concepts & Cases", 10th Ed, Pearson – Prentice Hall, N. Delhi
3. Cherunilam Francis, "Strategic Management: A Book on Business Policy & Corporate Planning", Himalaya Publishing House, Mumbai, 2008
4. Johnson & Scholes, "Explaining Corporate Strategy", 6th Ed, Pearson Education, Delhi

5. Kachru Upendra, “Strategic Management: Concepts and Cases”, Excel Books, N. Delhi
6. Barney Jay, “Gaining & Sustaining Competitive Advantage”, 2nd Ed, Prentice – Hall, N. Delhi
7. Patil Ashish, “Mergers & Acquisitions” SAAA Capital Pte. Ltd, Singapore
8. Renee Mauborgue, W. Chan Kim, Blue Ocean Strategy, Harvard Business Review, 2005
9. Gary Hamel, C.K. Prahalad, Competing for the Future, Harvard Business Review, 1994
10. Thomson, Strickland, Gamble & Jain, “Crafting & Executing Strategy”, 14th Ed, Tata McGraw – Hill, N.Delhi
11. Nag A, “Strategic Management – Analysis, Implementation & Control”, - Vikas Publishing House, 2011
12. Mintzberg Henry, “Strategic Safari”, 2009, Prentice - Hall Inc, New York.
13. Grant Robert, “Contemporary Strategic Management”, 6th Ed, Wiley India
14. Hit, Ireland, Hoskisson & Manikutty, “Strategic Management: A South – Asian Perspective”, 9th Ed, Cengage Learning, Delhi
15. Wheelen & Hunger, “Strategic Management and Business Policy”, 8th Ed, Prentice Hall, N.J.
16. Kazmi & Kazmi, “Strategic Management and Business Policy”, 4th Ed, Tata McGraw – Hill, N. Delhi
17. Rajiv Gupte & Shailesh Kale, “Strategic Management in the age of Globalization”, 1st Ed, Himalaya Publishing House, Mumbai, 2007 (proposed)

Assessment

Internal	40%
Semester-end	60%

Programme - Masters in Management Studies

Semester - III

FINANCE (CORE)

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Financial Markets and Institutions**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To understand different components of the Indian Financial system and their functions.
2	To comprehend various products issued through different financial institutions in the primary and secondary markets.
3	To understand the fixed income market, the different instruments and concepts related to it.

Prerequisites if any	Financial Management.
Connections with Subjects in the current or Future courses	International Business, International finance, Derivatives and Risk Management and Commodities.

S. No	Content	Activity	Learning Outcomes
1	**Indian financial system (IFS)** Historical evolution of IFS. Different components of the financial system and their functions Financial markets - primary and secondary markets; OTC and exchange markets; and equity and debt markets.	Lecture and classroom discussion	Understanding Indian financial system and its components
2	**The Role of the Central Bank – RBI** RBI's monetary policy in its proper perspective in the overall IFS.	Lecture and classroom discussion	Understanding the role of RBI in the IFS
3	**Stock Exchanges of the Country and Primary Markets.** Evolution of stock exchange and their role in shaping the financial scenario of a country.	Lecture and classroom discussion	Comprehension of SE functioning and various products issued by different financial institutions in primary market of India
4	**Secondary Markets** Products involved in domestic and foreign markets, institutions involved, stock and other exchanges, clearing house mechanisms and clearing corporation, broking houses and portfolio management services.	Lecture and classroom discussion	Ability to understand different financial products issued in domestic and foreign markets and the working of clearing houses, broking houses, stock exchanges

S. No	Content	Activity	Learning Outcomes
5	**Emerging Markets and Products** Alternate finance products and players, such as crowd funding, product to product finance, interest-free financial products, thematic indexes.	Lectures and classroom discussions	Understand new markets, products and players
6	**Derivatives** Products-Forwards, futures, options and swaps, Exotic options. Financial market activities – speculation, hedging and arbitrage.	Lecture and exercises	Ability to outline the basics of derivative products available in financial markets
7	**Intermediaries** Mutual funds, insurance firms and hedge funds, commercial banks and investment banks.	Lecture and classroom discussion	Ability to comprehend the working of intermediaries
8	**Fixed income securities** Bond characteristics, bond types, coupon types, computation of different yields and bond price, relationship between yield and price, floaters and inverse floaters.	Lecture and exercises	Ability to understand different concepts of fixed income securities
9	**Fixed income securities** Spot rates and forward rates, zero coupon yield curve, theories of term structure of interest rates. Fixed income risk measures: duration, modified duration, convexity and price value of basis point.	Lecture and exercises	Ability to understand and compute different measures of risk of fixed income securities
10	**Foreign Exchange Markets**	Lecture and classroom discussion	General understanding of currency markets and its role in the financial system

Text Books

1	Bharati V. Pathak, The Indian Financial System-Markets, Institutions and Services.
2	Mishkin and Eakins, Financial Markets and Institutions.
3	L M Bhole and Jitendra Mahakud, Financial Markets & Institutions.

Reference Book

1	Fabozzi, The Handbook of Fixed Income Securities.
2	Anthony Saunders, Financial Markets and Institutions.
3	Meir Kohn, Financial Institutions & Markets.

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Corporate Valuation and Mergers & Acquisitions**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objective

1	To understand the process and set of procedures to be used to estimate the value of a company.
2	To learn to make strategic decisions in M&A to enhance a company's growth.

Prerequisites if any	Financial management, Financial markets and institutions .
Connections with Subjects in the current or Future courses	SAPM, Investment banking and Venture capital and private equity.

Sr. No.	Content	Activity	Learning outcomes
1	**Over view of valuation** Approaches to valuation, valuation process, uses of valuation, information needed for valuation, Judicial and regulatory overview.	Lecture and classroom discussion	Understanding the basic concepts of valuation and the interplay of factors affecting valuation
2	**Financial statements, leverage and working capital from valuation perspective.**	Lecture and exercises	Understand the role of leverage, working capital and ratios in valuation
3	**Calculation of valuation inputs** Risk measurement, looking for relationships in data, cost of capital, FCFF and FCFE, growth rates.	Lecture and exercises	Ability to calculate the elements of risk, return and cash flows
4	**Discounted approaches to valuation** 1. Discounted Cash Flow Valuation a. Basics b. Estimating Inputs c. Discount Rates d. Growth flows e. Growth Patterns 2. Dividend discount model a. Constant growth model b. Zero growth model c. Two stage model d. H model e. Three stage model	Lecture and problem solving	Overview of valuation using discounted cash flow methods and ability to calculate the same

Sr. No.	Content	Activity	Learning outcomes
5	**Other Non-DCF valuation models** 1. Relative valuation model a. PE b. PEG c. Relative PE ratio d. Enterprise value multiples e. Choosing the right multiples 2. Book value approach 3. Stock and debt approach **Special cases of valuation** 1. Intangibles –Brand, Human valuation etc 2. Real estate 3. Start up firm 4. Firms with negative earnings 5. Financial service companies 6. Distressed firms 7. Valuation of cash and cross holdings 8. Warrant and convertibles 9. Cyclical & non-cyclical companies 10. Holding companies 11. E-commerce firm	Lecture and problem solving	Understanding of different alternative methods used in valuation
6	**Option pricing applications in valuation**	Lecture and problem solving	Understanding valuation of real options with help of binomial model and Black and Scholes model
7	**Writing a valuation report**	Lecture	Understanding the guidelines to be followed in valuation reports
8	**Introduction to Mergers & Acquisitions** Types of restructuring, regulatory considerations, takeover code, M&A process.	Classroom discussion	Understanding the various forms of business restructuring, the regulatory aspects and the M& A process
9	**M &A valuation and modeling** Inputs to valuation model, Inputs from due diligence and calculation of the value of the company.	Problem solving	Ability to calculate the value of a company
10	**Deal structuring and financial strategies** Negotiations, payment and legal considerations, tax and accounting considerations, financing of the deal.	Classroom discussion	Understand the different methods of financing, payment and tax considerations and other factors important for deal structuring
11	**Alternative business restructuring strategies** Joint ventures, strategic alliances, demergers or spin offs, split off, divestiture, equity carve out.	Classroom discussion.	Understanding the alternative business restructuring methods for creation of shareholders wealth

Text Books

1	Prasanna Chandra , Corporate Valuation
2	Donald M.Depamphilis , Mergers, Acquisitions and other restructuring activities.
3	Damodaran, Valuation
4	Ashish Patil , Mergers & Acquisitions – The art of science

Reference Books

1	Damodaran , Investment Valuation
2	Palepu, Healy and Bernard, Business Analysis and Valuation Using Financial Statements.
3	Sudi Sudarsanam , Creating Value from Mergers & Acquisitions.

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Security Analysis and Portfolio Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objective

1	To understand the factors affecting the prices of different assets and to create an optimum portfolio based on given risk conditions.
2	To understand the need for continuous evaluation and review of the portfolio with different techniques.
3	To learn technical analysis to predict price movements based on indicators and forecasting techniques.

Prerequisites if any	This subject requires basic knowledge of Financial management, financial markets and institutions.
Connections with Subjects in the current or Future courses	Investment banking, Corporate valuation.

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	**Introduction to securities**	Lecture and classroom discussion	Understanding the basics of securities
2	**Securities - Risk and return analysis** Types of securities, probability v/s absolute loss in risk management, volatility in prices, statistical tools for risk calculation.	Lecture and exercises	Understand the risk return analysis
3	**Efficient Market Hypothesis** Random walk theory, significance,usage.	Lecture and exercises	Ability to calculate prices using EMH
4	**Equity research and valuation** Sources of financial information, industry analysis, company analysis, valuation of equity shares.	Lecture and problem solving	Ability to carry on company analysis and valuation of equity shares
6	**Fixed income security analysis** Systematic and unsystematic risk, warrants and convertibles, bond valuation		Understand the fixed income securities
7	**Indexing and Benchmarking** Creation of an index, adjusting for corporate adjustments in the index, tracking an index.	Lecture and problem solving	Ability of creating and tracking index

Sr. No.	Content	Activity	Learning outcomes
8	**Technical analysis** Dow theory, types of charts. Japanese candle stick patterns, chart patterns, technical indicators.	Lecture and problem solving	Ability to carry on technical analysis
9	**Capital market theories** Capital asset pricing model, portfolio risk and return.	Lecture	Ability to apply capital market theories
10	**Factor models and arbitrage pricing theory** Factor based valuation models, Risk free arbitrage.	Classroom discussion	Understanding and applying factor models and APT
11	**Investment decision theory** Timing, allocation, buy, hold, sell, short.	Problem solving	Understanding and applying investment decision theory
12	**Portfolio theory** Construction and analysis, portfolio optimization, portfolio management strategies, portfolio performance measurement.	Classroom discussion	Understanding and applying portfolio theory

Text Books

1	Prasanna Chandra , Security Analysis and Portfolio Management.
2	Donald E Fischer, Roland J Jordan, Security Analysis and Portfolio Management.

Reference Books

1	Steven Achelis , Technical Analysis.
2	John Murphy , Technical Analysis of Financial Markets.

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**				
Title of the Subject / course	**:**	**Financial Regulations**				
Course Code	**:**					
Credits	**:**	**4**	**Duration**	**:**	**40**	

Learning Objective

1	To understand the regulations and its framework involved in financial system.
2	To learn major intricacies of financial regulations.

Prerequisites if any	
Connections with subjects in the current or future courses	Financial markets and institutions and mergers and acquisitions.

Sr. No.	Content	Activity	Learning Outcome
1.	**Introduction to Financial Regulations** Need and significance of Indian financial system regulations, structure of financial regulations in India, global financial crisis – response of the Indian regulations**.**	Lecture and discussion	Understanding the financial regulations framework and its significance in financial system
2.	**Reserve Bank of India (RBI)** Functions of RBI, credit control measures, qualitative credit control and quantitative credit control, regulatory measures taken by RBI to facilitate financial inclusion. **Securities and Exchange Board of India (SEBI):** Introduction to SEBI Act (1992) – powers and functions of SEBI.	Lecture, conceptual discussion and practical case examples	Clarity and understanding the framework of various financial regulatory and statutory bodies
3.	**Introduction to important SEBI Regulations pertaining to Capital Market:** • Issue of Capital and Disclosure Regulations (2009). • SEBI (Prohibition of Insider Trading) Regulations – 2015. • SEBI (Prohibition of Fraudulent and Unfair Trade Practices Related to Securities Market) Regulations – 2003. • SEBI Substantial Acquisition and Takeover Regulations – (2011). • Mutual Fund: SEBI (Mutual Funds) Regulations – 1996.	Lecture, conceptual discussion and practical case examples	Clarity and understanding of the regulatory framework with respect to SEBI in regulating the capital market

Sr. No.	Content	Activity	Learning Outcome
4.	**Insurance Regulatory and Development Authority (IRDA)** IRDA Act, Salient features of the IRDA Act, 1999, IRDA (protection of policy holder interests) Regulations 2002, its duties, power and functions of authority. **Competition Commission of India** Concept of competition , development of Competition Law, Competition Policy - Competition Act, 2002 - Anti Competitive Agreements, abuse of dominant position, combination, regulation of combinations, competition commission of India, appearance before commission and Appellate Tribunal, compliance of Competition Law.	Lecture and practical case discussion	Understanding the regulatory framework of IRDA and CCI
5.	**Foreign Exchange Management and Regulations** Objectives and definitions under FEMA, 1999,current account transactions and capital account transactions, establishment of branch, office etc. in India, realization and repatriation of foreign exchange, authorized person, penalties and enforcement, foreign contribution (Regulation)Act, 2010.	Lecture and practical case discussion	Understanding the significance of FEMA and foreign trade policy regulations framework
6.	**Prevention of Money Laundering** Genesis, prevention of Money Laundering Act, 2002, concept and definitions, various transactions, etc., obligations of banks and financial institution, KYC.	Lecture and case law discussion	Clarity on money laundering concept and its regulation
7.	**Regulatory framework for International Funds** Regulations framework for rising fund through: Global Depository Receipts (GDRs) and American Depository Receipts (ADRs), External Commercial Borrowings. **Foreign Direct Investment Regulations**: Foreign Direct Investment (FDI) Policy. SEBI (Foreign Portfolio Investors) Regulations -2014, SEBI (Alternate Investment Fund) Regulations – 2012.	Lecture, conceptual discussion and practical case examples	Understanding regulatory framework for international funds and commodity markets
8.	**Regulatory framework related to Credit Rating Agencies:** SEBI (Credit Rating Agencies Regulations) – 1999.	Lecture and discussion	Understanding the significance of regulating the credit rating agencies

Text Books

1.	Siddhartha Shankar Shah , Indian Financial System and Markets.
2.	Shashi K. Gupta and Nisha Aggarwal , Financial Services.
3.	Guruswamy , Merchant Banking and Financial Services.

Reference Books

1.	Madura , Financial Institutions & Markets.
2.	Seth, P.R Kulkarni, Justice A.B , Banking Regulation Act (Commentary).
3.	Guide to FEMA with Ready Reckoner and RBI Circulars .
4.	Ramamurthy, RBI Act .
5.	Ritika Garg and Bharat Agarwal ,Guide to Prevention of Money Laundering Act with Rules and Notifications.
6.	SEBI Manual, Taxmann.
7.	Manual Khilnani , FEMA.
8.	Taxmann , NBFC .
9.	Dr Anil Kumar , Corporate Laws .

Assessment

Internal	40%
External	60%

Semester	**:**	**III Core**			
Title of the Subject / Course	**:**	**Derivatives and Risk Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To understand the concepts related to derivatives markets and gain in-depth knowledge of functioning of derivatives markets.
2	To learn the derivatives pricing and application of strategies for financial risk management.
3	To acquaint learners with the trading, clearing and settlement mechanism in derivatives markets.

Prerequisites if any	Financial management, mathematics and statistics.
Connection with subjects in the current or Future courses	SAPM, Corporate Valuation, Investment Banking, Commodity Markets and International Finance.

Sr. No	Content	Activity	Learning outcomes
1	**Introduction to Derivatives** Economic functions of derivatives, application of derivatives – for risk management and speculation (Leveraging), basic terms and properties of options, futures and forwards.	Classroom discussion	Understanding the basics of derivatives markets
2	**Forwards and Futures** Pricing and valuation - futures and forwards, Risk management using futures, introduction to currencies, commodity and interest rate futures.	Classroom discussion and problem solving	Understanding the process of pricing and valuation of forwards and futures
3	**Mechanics and Properties of Options** Co-relation with underlying assets, boundary conditions for options, Put-call parity and its interpretation, synthetic options and risk free arbitrage.	Classroom discussion and problem solving	Understanding mechanics of options and creating synthetic options
4	**Option Trading Strategies** Directional strategies (Bull call spread, Bear put spread, Ladder, Ratio spreads), Non-directional strategy (butterfly, condor), Volatility based strategies (Straddle, Strangle, Calendar Spread), Hedging strategies (Protective put, covered call).	Classroom discussion/ problem solving/drawing graph and live trading	To understand pay off of each strategy

5	**Introduction to Options Valuation** Binominal Model for valuation, risk neutral probabilities and their interpretation, binomial model's application for American options where the underlying pays the dividend, Black and Scholes Model, log – normal distribution, interpreting the B & S formula, seeing options sensitivity to different variable.	Classroom discussion and problem solving	Valuations of options and creating scenario analysis using Excel
6	**Risk Management** Options sensitivity to the underlying, volatility, strike price, interest rate, time to expiration. Scenario analysis. Risk management using Greeks- Delta, Theta, Vega and Gamma risks of options, understanding options Greeks for various trading strategies (volatility and directional spreads), delta / dynamic hedging and relating the cost of Delta.	Classroom discussion	Understanding risk assessment methods and Options Greeks
9	**Options Volatility** Historical and implied volatility, volatility smile, term structure of volatility, some advance models of volatility estimation, value at risk, historical simulation, model building approach, stress testing and back testing.	Classroom discussion and problem solving	Understanding volatility and its relation to demand and supply of options
10	**Trading, Clearing and Settlement in Derivatives Markets** Meaning and concept, SEBI guidelines, Trading mechanism, learning mechanism-role of NSCCL, settlement mechanism, types of settlement, accounting and taxation aspect of derivatives trade.	Classroom discussion	Understanding the process of trading, clearing and settlement

Text Books

1	Redhead Keith, Financial Derivatives - An introduction to futures, forwards, options and swaps
2	Yadav Surendra S, Jain PK, Foreign exchange markets: understanding derivatives and other instruments
3	Hull John C. - Options, Futures and other derivatives

Reference Books

1	Bhaskar P Vijaya, Mahapatra B - Derivatives simplified: An introduction to risk management
2	Bhalla V K - Financial derivatives (risk management)

Assessment

Internal	40%
Semester-end	60%

Programme - Masters in Management Studies

Semester - III

FINANCE (ELECTIVES)

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Banking and Financial Services Institutions**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To understand different product and services provided by different financial institutions in India.
2	To comprehend various fund-based and fee-based services provided by financial institutions.

Prerequisites if any	Financial Management
Connections with Subjects in the current or Future courses	Commercial Banking, Financial Markets and Institutions, Investment Banking, Mutual funds and Wealth Management.

Module

S. No	Content	Activity	Learning Outcomes
1	**Introduction to Financial Services** Asset/Fund based services Fee based services.	Lecture and classroom discussion	Understanding different kinds of financial services available in Indian financial institutions
2	**Banking products and services** Loan-based services: retail loans, corporate loans, treasury products, housing finance, debt syndication, loan securitization. IT-based services: Internet banking and mobile banking- innovation in banking services.	Lecture and classroom discussion	Comprehension of various services and products available for retail and corporates by banks in India
3	**Insurance products and services** Concept, principles of insurance, types, major products, market players.	Lecture and classroom discussion	Ability to understand different insurance products and plans available in India
4	**Mutual Fund Products** Concept, types of mutual funds, other schemes and investment plans, REITS, costs involved.	Lecture, exercises and classroom discussion	Ability to comprehend different mutual fund products and plans available in India
5	**Leasing** Concept and classification, significance and limitation, accounting, reporting and taxation financial evaluation	Lecture, exercises and classroom discussion	Ability to understand concept of leasing and leasing procedures followed by various Indian financial institutions

S. No	Content	Activity	Learning Outcomes
6	**Hire purchase finance and consumer credit** Concept, accounting, reporting and taxation framework, financial evaluation.	Lecture, exercises and classroom discussion	Comprehension of hire purchase financing and consumer credit financing in India
7	**Factoring, forfeiting and bills discounting** Concept, factoring and forfeiting services in India, bill discounting schemes.	Lecture, exercises and classroom discussion	Ability to outline the factoring, forfeiting and bills discounting schemes
8	**Merchant banking services** Concept, merchant banking functions, pre-issue management services, post-issue management services.	Lecture and classroom discussion	Ability of paraphrasing the services involved in pre and post issue management
9	**Venture capital financing** Concept, types of venture funds, process of investment, investment valuation, structuring a deal, monitoring and follow-up.	Lecture and classroom discussion	Ability of understanding venture capital framework in India
10	**Credit Rating** Concept, credit rating agencies and their role, rating process and methodology, rating symbols and grades.	Lecture and classroom discussion	Outline the concept and process of credit rating in India

Text Book

1	M Y Khan, Financial Services.
2	Pratap Giri S , Investment Banking
3	Prashant Das and Divyanshu Sharma , Real Estate Finance in India

Reference Books

1	Khusboo Manoj, Financial Services, Centrum Press.
2	S Guruswamy, Essentials of Financial Services.
3	Williamson J Peter ,The Investment Banking Handbook

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Investment Banking**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objective:

1	The main objective of the course is to provide students with the necessary theoretical and conceptual tools used in investment banking.
2	This course will provide an introduction and general understanding of investment banking activities.
3	The final objective of this course is to show how corporate governance, ethics and legal considerations factor into investment banking deals.

Prerequisites if any	Financial Accounting, Financial Management with special reference to Financial Statement Analysis.
Connection with Subjects in the current or Future Courses	Financial Modeling, Corporate Valuation and Mergers and Acquisition.

Module

Sr No	Content	Activity	Learning Outcomes
1	**Introduction** Concept, evolution of Indian investment banking, regulatory framework, merchant banking v/s investment banking.	Lecture and discussion	Clarity and understanding of the basic concepts of investment banking
2	**Investment banking and allied activity** Core functions- book building, underwriting, merger and acquisitions and advisory, Asset management.	Lecture and numerical problems	Understanding of core functions of investment banking
3	**Market and security issuances** Introduction- equity and debt market**,** primary market investors**,** primary market intermediaries and support services providers**,** General statutory provision for issuance of securities.	Lecture and classroom discussions	Understanding the concept of market intermediaries, support service providers and regulatory provisions of market and security issuance
4	**Domestic issue management** Introduction-eligibility for issue management, Initial public offer, Follow on public offer, Important terms and provisions of ICDR regulation on public offers.	Lecture and classroom discussions	Understanding the concept of IPO, FPO and important provisions of ICDR
5	**Underwriting** Concept**,** underwriting in fixed and book built offer**,** assessment of an issue for underwriting.	Lecture and classroom discussions	Understanding the concept of underwriting as well as underwriters services in IPO process.

Sr No	Content	Activity	Learning Outcomes
6	**Mergers and Acquisitions** Business strategy, basics of mergers and acquisition, concept of value in the context of merger and acquisition, approaches to valuation in case of M & A, selection of appropriate cost of capital for valuation , shareholder value analysis, exchange ratio base for computation, post-merger integration process.	Lecture and discussion	Developing skills in valuation in an M & A setting
7	**Buyback and delisting** Introduction to share buyback and delisting, pricing of share buyback, types of delisting-Voluntary and compulsory .	Lecture and discussion	Understanding the buyback and delisting process
8	**Corporate Restructuring** Concept of corporate restructuring, rescue and insolvency, revival, rehabilitation and restructuring of sick units, securitization and debt recovery, winding up and corporate restructuring- external and internal.	Lecture and discussion	Understanding meaning, need and scope of corporate restructuring, models of restructuring, role of professionals in restructuring process
9	**Global capital market offers** Introduction**,** international bond market**,** depository receipts-ADR and GDR**,** international regulatory framework.	Lecture and discussion	Understanding international bond markets, GDR and ADR and international regulatory framework
10	**Private placements** Assessment of private placements-debt and equity, regulatory framework, transaction perspectives.	Lecture and discussion	Understanding the entire framework of private placements

Text Books

1	Joshua Rosenbaum and Joshua Peatl, Investment Banking: Valuation, Leveraged Buyouts and Mergers & Acquisitions.
2	Pratap Subramanyam, Investment Banking.

Reference Books

1	Pratap Giri S., Investment Banking.
2	Williamson J Peter , The Investment Banking Handbook.
3	H.R. Machiraju , Merchant Banking

Assessment

Internal	40%
Semester End	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Investment Banking**			
Course Code	**:**				
Credits	**:**	**4**	**Credits**	**:**	**40**

Learning Objective

1	To understand the basic concepts and fundamentals used in wealth management.
2	Capability to design appropriate portfolio for the investors based on their risk appetite.

Prerequisites if any	Financial Management
Connection with Subjects in the current or Future Courses	Financial Markets and Institutions, SAPM

Module

Sr No	Content	Activity	Learning outcomes
1	**Introduction to Wealth Management** Meaning, scope, components, process of wealth management, functions of investment advisor, independent advisors, wire house wealth managers, code of ethics for wealth managers.	Lecture and discussion	Clarity and understanding of the basic concepts in wealth management
2	**Need and expectations of clients** Wealth management client categories mass affluent, high net worth individual, ultra high net worth, unified households, software solutions for advisors, client on boarding- profiling, financial planning, goal setting, managing asset, controlling liabilities, planning taxes, diversification, life cycle management.	Classroom discussion	Ability to apply the principles and concepts of wealth management
3	**Investment planning** Types of investment risk return expectations versus risk appetite.	Lecture and discussion	Understanding risk-return trade off
4	**Wealth creating asset classes** Equity Investment: Sector exposure and diversification, fundamental and technical analysis, investment and speculation, leveraging. Debt Investment**:** Deposits and debt securities, yields and interest rate risk, concentration risk, passive investments in debt.	Lecture and discussion	Detailed and in depth understanding traditional asset classes
5	**Alternate assets** Gold, real estate, art, mutual fund, derivatives and structured funds, hedge funds and commodities.	Lecture and discussion	Detailed and in depth understanding of alternate asset class

Sr No	Content	Activity	Learning outcomes
6	**Portfolio modelling** Portfolio modelling, monitoring tolerance and rebalancing, substitution, portfolio performance measurement, attribution and reporting, portfolio management models, pooled funds, technology absorption and use of social media in wealth management and advantages to investment advisors.	Classroom discussion and exercises	Understanding the principles of portfolio modelling and its practical use
7	**Insurance Planning** Life insurance- types of policies, general insurance, health insurance- mediclaim, calculation of Human Life Value.	Classroom discussion and exercises	Understanding the importance of insurance, the various insurance policies and ability to calculate HLV
8	**Retirement Planning** Purpose and need, life cycle planning, wealth creation- factors and principles, pre and post – retirement strategies- tax treatment, various tax savings schemes, pension schemes, annuities.	Classroom discussion and exercise	Understanding the concepts of retirement planning and tax implications
9	**Estate planning** Estate planning concept, types of will, requirements of a valid will, trust – deductions –exemptions.	Classroom discussion and exercises	Ability to prepare a will

Text Books

1	Harold R Evensky , Wealth Management
2	Nalinipruva Tripathi , Wealth Management
3	S. K. Bagchi , Wealth Management

Reference Books

1	Herbert B Mayo , Investments-An Introduction,
2	S. Kevin , Portfolio Management
3	Suyash Bhatt , Wealth Management
4	V.K. Bhalla ,Investment Management
5	Jones, Wiley , Investment: Principles and concepts

Assessment

Internal	**40%**
Semester End	**60%**

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Infra and Project Finance**			
Course Code	**:**				
Credits	**:**	**4**	**Credits**	**:**	**40**

Learning Objective

1	To learn different sources of project and infrastructure financing.
2	To understand regulatory framework, policies, procedures of project and infrastructure financing.

Prerequisites if any	Financial Management
Connections with subjects in the current or future courses	Project Management, BFSI

Module

Sr No	Content	Activity	Learning outcomes
1	**Project planning** Generation and screening of project idea, tools for identifying investment opportunity, corporate appraisal, project rating index and sources of positive NPV.	Lecture and discussion	Understanding of the basic concepts of project planning
2	**Project analysis** Market and demand analysis, technical and financial analysis, legal and political analysis.	Classroom discussion and explanation	Ability to apply the principles and concepts of project analysis – market demand, technical and financial
3	**Social cost benefit analysis** Determination of economic life-inflation, investment and capital budgeting, rationale for SCBA, UNDIO approach, Little- Mirlees approach, SCBA by financial institutions.	Lecture and discussion	Detailed and in depth understanding of Social Cost- benefit Analysis
4	**Project risk and return analysis** Sources and measurement of risk, assessment of credit, cash and working capital risk , gestation periods and project rate of return, due diligence in appraisal of infrastructure projects.	Classroom discussion and exercises	Understanding the principles of project risk and return
5	**Sources of project financing** Lending schemes of financial institutions, venture capital- concepts, functions and schemes, equity and debt special purpose vehicles and Viability Gap Financing (VGF).	Classroom discussion and exercises	Understanding the sources of project finance and application in right situation

Sr No	Content	Activity	Learning outcomes
6	**Infrastructure Development** Introduction, multiplier effects of infrastructure development on economic development of the nation.	Classroom discussion	To understand how investment in infrastructure creates opportunities and efficiencies in other sector
7	**Public private partnership model** Concept, scheme and modalities of PPP, Financial and Economic Appraisal of infrastructure Projects; PPP models like Build-operate-transfer (BOT), Build-own-operate-transfer (BOOT), build-own-operate (BOO), Build- lease-transfer (BLT), Design-build-finance-operate (DBFO), Design-build-operate-transfer (DBOT) and Design-construct-manage-finance (DCMF).	Classroom discussion and exercises	Understanding the concepts of Public Private Partnership Model
8	**Due Diligence and Project Appraisal** IRR,MIRR, NPV, Pay-Back period, Profitability Index.	Classroom discussion and exercises	Understanding the due-diligence process and various techniques of project evaluation
9	**Earned Value Analysis of project** Risk management of infrastructure projects, risk mitigation strategies.	Classroom discussion and exercises	Understanding risk in project, risk analysis techniques and ways to minimize risk using Earned value Analysis
10	**Project Funding** Sponsors, other equity providers, senior debt providers, junior debt provider.	Classroom discussion and exercises	Understanding the role of various contractual parties in project funding
11	**Loan syndication** Loan origination, process, closing and foreclosure. .	Classroom discussion and exercises	Ability to execute the loan syndication process
12	**Debt restructuring** RBI guidelines, process and procedures.	Classroom discussion and exercises	Understanding the concepts of debt restructuring
13	**Asset securitization** Concept, types and advantages.	Classroom discussion and exercises	Basic understanding of asset securitization
14	**Regulatory framework** SARFAESI Act, Land Acquisition Bill, related provisions of Income Tax Act.	Classroom discussion	Understanding the regulatory framework that affects project and infra finance

Text Books

1	Prasanna Chandra,Projects Planning, Analysis, Selection, Implementation & Review
2	Abhijit Dutta, Infrastructure Finance

Reference Books

1	M.R. Umarji, Securitization and Reconstruction of Financial Assets and enforcement of security Interest.
2	Prabuddha K Das , PPP and Project Finance.

Assessment

Internal	**40%**
Semester End	**60%**

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Strategic Cost Management**			
Course Code	**:**				
Credits	**:**	**4**	**Credits**	**:**	**40**

Learning Objective

1	To understand the concepts and techniques in cost and management accounting.
2	To learn the application of cost and management accounting techniques in strategic decision making.

Prerequisites if any	Knowledge of Cost and Management Accounting.
Connections with Subjects in the current or Future courses	Strategic management.

Module

Sr. No	**Content**	**Activity**	**Learning outcome**
1	**Cost Management tools** • CVP analysis for decision making • Lean Manufacturing and Quality Control • Life cycle costing • Kaizen costing, • JIT & theory of constraints, • BPR and bench marking, • Flexible Manufacturing Systems (FMS), • Total Quality Management (TQM) • Lean Costing • Target Costing	Classroom discussion/ Problem solving/exercises	Detailed and in depth understanding of various cost management tools
2	**Activity Based Costing** Nature of activity-based costing (ABC), benefits and limitations of ABC, limitation of volume -based costing system, indicators of ABC, activity hierarchies, cost drivers, designing an ABC system Activity-based management, operational and strategic application of ABC, customer profitability analysis.	Classroom discussion/ With problem solving /exercises	Ability to identify activities in an organization and assign the cost of each activity with resources to all products and services according to the actual consumption by each. Ability to prepare profit statement under ABC system
3	**Lean costing** Concept, application to accounting process, lean performance measurements, financial reports for lean operations.	Classroom discussion and problem solving	Ability to apply lean costing methods to accounting processes

Sr. No	Content	Activity	Learning outcome
4	**Life- cycle costing** Introduction, Life-cycle costing analysis, importance of life-cycle costing to a utility, life-cycle costing methodology, life-cycle cost estimation.	Classroom discussion and problem solving	Understanding and applying the concept of life-cycle costing
5	**Kaizen costing** Concept, need, system.	Classroom discussion and case discussions	Understanding and applying the concept of kaizen costing
6	**Target costing** Basics and meaning, phases in target costing, streamlining the processes, traditional cost system versus target costing.	Classroom discussion and numerical exercises	Understanding and applying the concept of target costing
7	**Environmental costing** Environmental costs- internal and external	Classroom discussion	Understanding and applying the concept of environmental costing
8	**Strategic cost management** Conceptual framework, environmental influences on cost management practices. Pillars of SCM: - Cost driver analysis. - Strategic positioning analysis.	Classroom discussion	Understanding the basic concepts of SCM
9	**Value Chain Analysis and Long Term Cost Management.** Nature of value-chain analysis, activity analysis and linkage analysis, application of linkage analysis in cost reduction and value addition. Value Engineering.	Classroom discussion	Understanding the concepts and recognizing, which activities are the most valuable (i.e. are the source of cost or differentiation advantage) to the firm and which ones could be improved or outsourced to provide competitive advantage
10	**Costing and Strategies** Blue ocean and red ocean strategy, Judo strategy, Edge strategy, Three box strategy.	Classroom discussion	Understanding strategy implementation and its impact on costing

Sr. No	Content	Activity	Learning outcome
11	**Performance Evaluation** Balance Score Card Concept, prospective and limitations, establishing objectives and performance measures in different perspectives of balance score card, productivity measurement and control, quality cost management and reporting, Benchmarking and standard costing, Budgeting and Budgetary control, Transfer Pricing, Triple bottom line and sustainability, Measuring performance ROI ,EVA, ROCE, Cost Benefit analysis.	Classroom discussion/ With problem solving/exercises	Understanding the concepts of Balance Score Card, benchmark costing , how to prepare and analyse various functional budgets and master budget. To apply performance measures- ROI , EVA,ROCE. To conduct Cost- Benefit Analysis
12	**Cost Audit and Management Audit under Companies Act** Inflation accounting, Goodwill accounting, SOX audit, Energy and Environmental audit, strategic assessment of cost and managerial performances, price fixation.	Classroom discussion	Understanding the concepts and difference between Cost Audit and Management Audit. To understand Inflation accounting, Goodwill accounting, SOX audit, Energy and Environmental audit

Note: *Topics on Activity Based Costing, Life-Cycle Costing, Target costing and Environmental costing are to be discussed at a higher level with more focus on applications since the basics of these topics have been covered in ' Cost and Management Accounting' in Semester-II.*

Text Books

1	Vijay Govindarajan , Strategic Cost Management.
2	Horngren and Datar , Cost Management

Reference Books

1	Roert S. Kaplan and Anthony A Atkinson , Advanced Management Accounting
2	Bolcher Chen/Lin , Cost Management: A strategic Emphasis
3	Girish Jakhotiya ,Strategic Financial Management

Assessment

Internal	40%
Semester End	60%

Semester	**:**	**III –Elective**			
Title of the Subject / Course	**:**	**Commodities Markets**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To gain the knowledge of emergence of commodities markets and understand its future.
2	To understand the dynamics of world commodities markets.
3	To understand the ecosystem of Indian commodities markets.
4	To acquaint learners with the trading, clearing and settlement mechanism in commodities markets.

Prerequisites if any	
Connection with subjects in the current or Future courses	Derivatives Markets and Financial Markets & Institutions

Module

Sr. No	Content	Activity	Learning outcomes
1	**Introduction to Commodity Markets** History of commodities markets, physical commodity markets in India (spot and forward), and commodity futures markets in India, future prospects of Indian commodity markets.	Classroom discussion	Understanding emergence of commodities markets and its future
2	**International Commodity Markets** Dynamics of global commodity markets, international commodity exchanges.	Classroom discussion	Understanding dynamics of world commodities markets
3	**Regulatory Framework of Indian Commodities Markets** Role of Government & other agencies in strengthening commodities markets, regulations relating to commodities markets, Forward Contracts Regulation Act, 1952 (FCRA), Forward Market Commission (FMC), Securities Contract Regulation Act, 1956 (SCRA), SEBI, Agricultural Produce Market Commission Act (APMC), Essential Commodities Act, 1955 (ECA), Prevention of Black-marketing of supplies of Essential Commodities Act, 1980 (PBMSECA), Central Warehousing Corporation Act, 1962 (CWCA), Agricultural Produce Grading and Marking Act, 1937 (APGMA), Standard Weights and Measures Act, 1956 (SWMA).	Classroom discussion	Understanding ecosystem of Indian commodities markets

Sr. No	Content	Activity	Learning outcomes
4	**Trading on Indian Commodities Exchanges** Commodity futures trading on Indian exchanges, trading on Indian commodity specific regional exchanges, trading on national level demutualized commodity derivatives exchanges in India, trading on national level demutualized commodity spot exchanges in India.	Classroom discussion	Understanding trading, clearing and settlement mechanism
5	**Commodities Futures Pricing** Contango and backwardation, futures of perishable goods, risk free arbitrage, cost of carry.	Live market prices and discussion	Understanding the arithmetic behind commodity derivative prices
6	**Currency and Commodities Arbitrage** Arbitrage among international prices of precious metals.	Classroom discussion	Understanding global demand and supply for commodities
7	**Commodities Options** Call, put, option strategies, synthetic options, implied volatility.	Classroom discussion	Understanding options and its use in strategies
8	**Risk Management and Hedging with Options** Covered call and protective put strategies. option Greeks.	Classroom discussion	Understanding Excel based scenario analysis and risk management
9	**Information and Linkages** Role of information in commodity markets, linkages between equity markets and commodity markets, commodity market scams.	Classroom discussion	Interdependence of equity, commodity and forex markets

Text Books

1	S P Das, Commodities Markets .
2	Gala**,** Guide to Indian commodity markets.
3	Bhambwani**,** A traders guide to Indian commodities market.

Reference Books

1	Neeraj Mahajan & Kavaljit Singh, A beginner's guide to Indian commodity futures markets

Assessment

Internal	40%
Semester End	60%

Semester	**:**	**III –Elective**			
Title of the Subject / Course	**:**	**Mutual Fund**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1.	To get complete understanding of mutual fund industry.
2.	Students should understand how mutual funds are marketed and how the schemes are to be evaluated.
3.	Students should get oriented to the legalities, accounting, valuation and taxation aspects underlying mutual funds and their distribution.

Prerequisites if any	Financial Management
Connection with subjects in the current or Future courses	Financial Markets and institutions, Wealth Management.

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Introduction** Investment avenues, concept and role of mutual fund, comparison of mutual fund with equity and bond instruments and history of MF in India.	Lecture and classroom discussion	Understanding the concepts of investing in mutual fund
2	**Different types of funds** Scheme selection, expense ratio, income ratio, portfolio turnover rate and transaction costs.	Lecture, exercises and assignment	Ability to select mutual fund schemes
3	**Structure and key constituents of mutual fund** Sponsor, trustees, AMC, custodians, depositories and distributors.	Lecture and classroom discussion	Understanding the MF Industry and the players
4	**Legal and regulatory framework** AMFI, RBI and Companies Act.	Lecture and classroom discussion	Understanding the regulatory framework
5	**Net Asset Value** Calculation of NAV, accounting, valuation and tax implications.	Lecture, Exercises	Ability to calculate NAV
6	**Financial planning** Overview of financial plan, financial planning strategies, asset allocation and wealth management.	Lecture and And Exercises	Ability to make financial plan and maximize the wealth of investors
7	**Marketing of units** Selecting the right investment products for investors, fund distribution and channel management practices.	Lecture and classroom discussion	Ability to market the financial products

Sr. No.	Content	Activity	Learning outcomes
8	**Portfolio management** Risk & return trade off and risk adjusted returns.	Lecture and classroom discussion	Understanding the risk and return theory and creating a portfolio
9	**Measuring fund performance** Benchmarking and quantitative measures used for analysis.	Lecture and Exercises	Using quantitative tools to measure the performance of mutual fund
10	**Protection of investors** RTI, customer grievances.	Lecture and classroom discussion	Understanding the investors' rights

Text Books

1.	Sundar Sankaran , Indian Mutual Funds Handbook .
2.	Rutherford Ronald K., The Complete Guide to Managing a Portfolio of Mutual Funds .

Reference Books

1	Sen, Joydeep , Mutual Funds in India: Vehicle for Fixed Income Investments .
2	NCFM AMFI Book

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / Course	**:**	**Financial Modelling**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To develop excel proficiency.
2	To learn how to develop models in various areas of finance.

Prerequisites if any	Financial Management
Connection with subjects in the current or Future courses	Corporate Valuation, Mergers and Acquisitions and Investment Banking.

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Introduction to Financial Modelling.** Introduction to financial modes-static vs dynamic models, need and applications. **Excel Proficiency** Formatting of excel sheets, use of excel formulae function, data filter and sort, charts and graphs, table formula and scenario building, lookups, pivot tables.	Classroom session and computer lab session	To understand the concept and methodology of financial modelling and to strengthen concepts of Excel to be used in modelling
2	**Combining the Tools and Theory into the model** Define and structure the problem, define the input and output variables of the model, decide users of the model, understand the financial and mathematical aspects of the model, design the model, create the Spread sheet, test the model, protect the model, document the model, maintain the model.	Classroom Session with lab session	To understand the basic tools of financial modelling
3	**Financial Feasibility Model from Start to Finish** Inputs - assumptions, intermediate statements, capital expenditure statement, sources of finance and debt servicing, production, income and expense statements, working	Lecture with lab session	To understand the practical applications of basic financial functions

Sr. No.	Content	Activity	Learning outcomes
	capital statements, depreciation schedule, loan amortization. Outputs - profit and loss statement, balance sheet, cash flow, key ratios, project IRR and equity IRR, payback, sensitivity analysis, summary of key results to top management.		
4	**Project Finance Modelling** Introduction, requirements, advantages risks- analysis and mitigation, financial model, inputs, sensitivity and cost of capital, construction, borrowing and output, preparing projected financial statements including cash flow, evaluating a projects debt capacity and cash flow waterfall, measuring expected rates of return, sensitivity analysis.	Lecture with lab session	Learn the different aspects and nuances required for project assessment, planning and funding
5	**Equity Research Modelling** Prepare an income statement, balance sheet, cash flow statement, geographic revenue sheet, segment revenue sheet, cost statement, debt sheet, analyze revenue drivers forecast geographic revenues, segment revenues, geographic revenues, cost statement, debt, income statement, balance sheet, cash flow statement. performa adjustments, income statement-compute margins, balance sheet-compute ratios cash flow statement projection, valuation – discounted cash flow method (DCF), valuation –relative valuation (football field chart) Valuation – assumptions for valuation model, prepare valuation model, prepare presentation sheets.	Lecture with lab session	To understand application of Excel in equity research modelling
6	**Report writing** Initiating coverage**,** result update reports, events and other reports, industry report.	Lecture with lab session	To learn report writing skills
7	**Portfolio Optimization and Risk** Develop model based on two assets portfolio,	Lecture with lab session	To understand complex portfolio allocation situations and the

Sr. No.	Content	Activity	Learning outcomes
	develop model based on more than two assets (n assets) portfolio, variance covariance matrix, creating efficient frontier for asset allocation, using solver to find minimum variance portfolio and optimal(market portfolio) in n asset case, CML model, calculation of beta based on data gathered from any stock exchange.		importance of diversifications understand BETA and its calculation based on real data
8	**Visual Basic Environment (VBE)** Understanding the basics of macros, recording of macros.	Lab Sessions	To understand how VBE can be used to enhance the power of Excel

Text Books

1	C. Sengupta, Financial Modelling using Excel and VBA
2	Alastair L. Day, Mastering Financial Modelling in Microsoft Excel
3	Simon Beninga, Financial Modelling

Reference Books

1	Alistair L. Day, Mastering Risk Modelling.
2	Dr. Manu Sharma, Mergers and Acquisitions and Corporate Valuation- An Excel Based Approach.
3	John D. Finnerty , Project Financing- Asset based financial Engineering.

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / Course	**:**	**International Finance**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1	To understand the dynamics underlying the global economic environment, trade policies and barriers, cross-border flows of capital, risk profile of international investors, ways of managing risk emanating from newer and unchartered sources of risk and changing trade-off between desired return and risk with special reference to the Indian economy, the US economy and the Euro-zone.
2	To learn the concepts and terminology related to fundamentals of international finance, foreign exchange markets and arithmetic, currency and interest rate swaps, exchange rate regimes, interest rate and purchasing power parity, balance of payments, historical perspective on exchange rates, gold standard, Bretton Woods system, fixed and fluctuating rate regimes, euro currency markets, international equity markets and international debt markets.
3	To understand the regulatory framework for financing international operations

Prerequisites if any	Financial Management
Connection with subjects in the current or Future courses	Derivatives and Risk Management, International Business and Financial Regulations.

Module

Sr No	**Content**	**Activity**	**Learning outcomes**
1	**Fundamentals of International Finance** Introduction to international finance, balance of payment current account, capital account and reserve account, determinants of demand for and supply of currency, exchange rate and factors affecting exchange rate, current account deficit, balance of trade and their implications on exchange rates.	Classroom session and classroom discussion	To understand the basic concepts related to international finance
2	**International Economics** Globalization, socialism and communism, protected economies, international grants, IMF .	Classroom session	To understand international economics
3	**International Monetary System Inputs** Introduction, Barter System, Bimetallism and Classical Gold Standard, Bretton Wood System, SDRs and Smithsonian agreements, Fixed and Floating Rate System , European Monetary System	Lecture with lab session	To understand the International Monetary System

Sr No	Content	Activity	Learning outcomes
4	**Foreign Exchange Markets** Exchange rate quotations, direct and indirect rates, cross currency rates, vehicle currency, spreads and calculation of cross rates, settlements – cash, tom, spot and forward., arbitrage, speculation and trading, interest rate parity and purchasing power parity, covered interest rate parity in arbitrage, borrowing and investment decisions, calculation of forward rates through use of forward schedules, annualized forward margin, calculation of swap points.	Lecture with classroom discussions.	Understanding of the foreign exchange market
5	**Euro Currency Markets** Origin and reasons for growth of Euro currency markets, their characteristics and components, Euro currency deposits, loans, bonds and notes, Off shore banking, tax havens.	Lecture with classroom discussions.	To understand Euro currency market
6	**International Equity Markets:** Global depository receipts and American depository receipts, foreign currency convertible bonds, foreign direct investments and foreign portfolio investments, participatory notes.	Lecture with classroom discussions.	To understand international equity market
7	**International Debt Markets** Introduction, international bond markets features of foreign bonds, features of euro bonds, risks in international bonds.	Lecture with classroom discussions.	To understand international debt market
8	**Currency Forward and Futures** Forward and future contracts, non-deliverable forwards, currency futures terminologies, pricing currency futures, hedging, speculation and arbitrage with forwards and futures.	Lecture with classroom discussions.	To understand currency, forwards and futures
9	**Currency Options** Introduction, option terminologies, options pay-offs, hedging with currency options, range forward, zero cost collar, participating forward, barrier options, asian options innovation in options.	Lecture with classroom discussions.	To understand currency options

Sr No	Content	Activity	Learning outcomes
10	**Swaps** Interest Rate Swaps and currency swap.	Lecture with classroom discussions.	To understand swaps
11	**Capital Budgeting for International Project Investment Decisions** Calculation of DCF, Project IRR, NPV and pay-back period, impact of transfer pricing.	Lecture with classroom discussions.	To understand capital budgeting appraisal techniques in international project investments
12	**Risk Management** Management of risk in international trade/ business operations.	Lecture with classroom discussions.	To understand risk involved in global trade.

Text Books

1	Jeff Madura , International Financial Management
2	Siddaiah , International Financial Management: An Analytic Framework.

Reference Books

1	Prakash G Apte , International Finance: A Business Perspective.
2	Moosa , International Finance: An Analytic Approach.

Assessment

Internal	40 %
Semester end	60%

Semester	:	**IV – Elective**			
Title of the Subject / Course	:	**Commercial Banking**			
Course Code	:				
Credits	:	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objective

1.	To understand the concepts and fundamentals of Commercial Banking,
2.	To understand the Structure and growth of banking and various services rendered through commercial banks.

Prerequisites if any	Financial Management and Financial Markets and Institutions, Investment Banking and BSFI.
Connections with Subjects in the current or future courses	

Sr.No.	Content	Activity	Learning Outcome
1.	**Introduction to Commercial Banking** Banking structure, growth/history of Indian banking, banking sector reforms.	Lecture and discussion	Knowledge and understanding of the history of Indian banking, banking sector reforms and related areas
2.	**Banking Operations** Retail liabilities, retails assets, KYC, ALM and preventive vigilance.	Lecture and discussion	Understand basic schemes of deposit and credit, dangers of money laundering and usefulness of preventive vigilance
3.	**Banking products** Fund based and fee based, term loan/working capital, appraisal process.	Lecture and discussion	Understand types of credits - term loan and working capital and how to appraise a credit proposal
4.	**Legal Aspects of Banking** Negotiable Instrument Act, Banking Regulation Act and RBI circulars.	Lecture and discussion	To understand important banking laws
5.	**Rural Banking** India's agrarian sector and banking, regional rural banks, priority sector and micro-finance differentiated banks, financial inclusion.	Lecture and discussion	Understand measures taken towards financing priority sector schemes
6.	**Study of Bank financial statement** Components of Balance Sheet and Profit and Loss Statement, important ratios of bank performance- CAMEL framework, composition of items contributing to net profit.	Lecture and discussion	Understand how to evaluate a bank's performance
7.	**IRAC Norms / NPA Management** Reasons, impact on banking	Lecture and	Understand intricacies of asset quality deterioration and impact

	performance and economy, measures taken to minimize NPA.	discussion	on banks
8.	**Risk Management in Banks** Credit, market and operational risks.	Lecture and discussion	To know the various risks in banking operations and tools of management of risks
9.	**Capital Adequacy Norms** Importance of capital for banks, Basel I/II/III and CAR.	Lecture and discussion	To be aware of significance of capital adequacy regulation and impact on banks
10.	**Treasury** Role and functions of integrated treasury.	Lecture and discussion	Understand foreign exchange and money market operations.
11.	**Asset Liability Management** Interest spread, NIM.	Lecture and discussion	To understand importance of ALM and its impact on profitability
12.	**Regulatory Role of RBI** Functions of RBI, role of monetary policy, prudential norms.	Lecture and discussion	To know the role and functions of Central Banks in supervision and control of commercial banks
13.	**Retail banking products** Housing loan, personal loan, automobile loan, education loan.	Lecture and discussion	To understand various banking products of retail banks

Text Books

1	Indian Institute of Bank Management , Advanced Bank Management.
2	Vijayraghawan Iyengar, Introduction to Banking.
3	Raghu Palat , Retail Banking.

Reference books

1	Bharati V Pathak , The Indian Financial System.
2	Shri. S K Das, Tits Bits of General Banking.
3	Shri. S K Das , Tits Bits of General Advances and Financial Services.
4	Sukhvinder Mishra , Banking Law and Practice.
5	Indian Institute of Banking and Finance, Legal aspects of Banking Operations.

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**IV- Elective**			
Title of the Subject / course	**:**	**Business Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To gain understanding of relevant statistical tools applicable for Business Analytics.
2	To learn data mining techniques using Excel and R.
3	To evaluate various models of Business Analytics.

Prerequisites if any	Knowledge of Statistics and MS Excel
Connection with subjects in the current or Future courses	Financial Modelling

Sr.No.	Content	Activity	Learning outcomes
1	**Introduction to Analytics** Meaning, application areas of business analytics, techniques of analytics.	Classroom discussion	Basic understanding of business analytics
2	**Statistics for Business Analytics** Central tendencies and dispersion, central, limit theorem, sampling distribution, hypothesis testing, simple linear regression, categorical data analysis, analysis of variance (ANOVA), non-parametric tests.	Discussion and practical using software	Ability to apply various statistical tools and techniques in the process of business analytics
3	**Advanced Excel Proficiency** Describing Numeric Data, Pivot Table Analysis, Linear Regression, Comparing Two Sample Variances, Comparing Two Sample Means, Pair T Test, One Way ANOVA, Two Way ANOVA, Generating Random Numbers, Rank and Percentile, Histogram Procedure, Exponential Smoothing and Moving Average, Sampling, Covariance and Correlation, Goal Seek and Solver.	Discussion and practical on MS excel	Use of advanced Excel functions
4	**Understanding R** Using R Studio, working with data in R, R procedures.	Discussion and practical cases on R	To understand use of R
5	**Data Mining using Decision Tree** Introduction to decision trees, model design and data audit, demo of decision tree development, algorithm behind decision tree and other decision tree.	Discussion and practical using software	Data mining techniques using R
6	**Data Mining using clustering in R**	Discussion and	Data mining techniques

	Understanding cluster analysis using R, clustering as strategy, hierarchical clustering, non-hierarchical clustering - K means clustering, variants of hierarchical clustering, different distance and linkage functions.	practical using R software	using R
7	**Time Series Forecasting** Time series vs causal models moving averages, exponential smoothing, trend, seasonality, cyclicity causal modelling using linear regression forecast accuracy.	Discussion and practical using software	Data mining techniques using R
8	**Predictive Modelling – Logistic Regression using R** Data import and sanity check, development and validation, important categorical variable selection, important numeric variable selection, indicator variable creation, stepwise regression, dealing with multicollinearity, logistic regression score and probability, KS calculation, coefficient stability check, iterate for final model.	Discussion and practical using R Software	Evaluation of models
9	**Overview of Big Data and Hadoop** Big data and Hadoop and concept, application, cloud computing, generators of big-data.	Classroom discussion	Understand tools of business analytics
10	**Data Analysis and Applications** Credit risk analytics, fraud risk analytics, financial services marketing analytics.	Classroom discussion	Ability to apply business analytic tools

Text Books

1	Laursen & Thorlund, Business analytics for managers.
2	Balram Krishnan , Business analytics: concepts and theories.
3	R N Prasad and Seema Acharya , Fundamentals of business analytics.

Reference Books

1	Thomas W Miller , Modelling techniques in predictive analytics
2	Lander ,R for everyone: advanced analytics and graphics
3	Evans ,Business analytics

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**IV – Elective**			
Title of the Subject / course	**:**	**Venture Capital and Private Equity**			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To develop general understanding of the venture capital and private equity industry globally and the various players involved.
2	Provide an understanding of the private equity investment process starting from fund raising to exiting.
3	Develop analytical valuation and deal structuring techniques used in venture capital and buyouts.
4	To prepare students for future jobs in VCPE and related industries.

Prerequisites if any	Financial Management
Connection with subjects in the current or Future courses	Project and Infra Finance, Mergers and Acquisitions and Investment Banking.

Sr. No.	Content	Activity	Learning outcomes
1	**Introduction and Overview of Venture Capital and Private Equity.** Overview and history of venture capital industry, evolution of private equity industry and venture capital industry, how to choose and approach a venture capitalist, structure and terms of venture capital and private equity firms.	Classroom discussions	Understanding of private equity process
2	**Process of Venture Capital and Private Equity Funding** Venture capital cycle and private equity process.	Classroom discussions and explanation	Understanding how corporates invest in a new private equity
3	**Investment Selection, Fund Raising Challenges** Sources of capital, alternative forms of fund raising and fundraising process and fallacies.	Numerical solving and classroom discussions	Awareness of the current investing patterns, problems and issues faced by industries and PE investors
4	**Valuation Methods and Techniques** Deal valuation and deal terms.	Numerical and classroom discussions	Understand financial valuation methods and strategies and the impact of dilution

5	**Structuring Term Sheets** Environmental factors surrounding term sheets, selected critical elements in venture term sheets.	Classroom discussions and explanation	Integrating the valuation with term sheet
6	**Document and Typical Investment Conditions** Due diligence procedures.	Classroom discussion	Understanding documents and critical pointers to due diligence
7	**Exit Strategies for Multiple Stakeholders** Consider liquidity events such as IPO, mergers, later stage financing, including mezzanine financing and buy-outs.	Classroom discussion and explanation	Understanding strategies made to negotiate and exit the fund
8	**Regulation of PE Funds** SEBI Alternative Investment Funds (AIF) Regulations.	Classroom discussion and explanation	Understanding PE funds regulation
9	**Tax Aspect of PE Investment** Section 10(23FB) of Income Tax Act, 1961 Section 10(47) of Income Tax Act, 1961 Income types, Securities Transaction Tax, Dividend Distribution Tax, STCG, LTCG, Taxation of Non Residents.	Classroom discussion and explanation	Overview of taxation aspects while choosing PE as an investment alternative
10	**Private Equity Investments in Developing Markets**	Classroom discussion	To know the trends of the PE funding in the developing economies
11	**Private Equity, Corporate Governance and Ethics** Board members duty to shareholders, composition and roles of the board of directors in the private company.	Classroom discussion	Importance of ethics and value system

Text Book

1	T Satyanarayan Chary , Venture Capital concepts & Applications
2	Vandana Pawar , Venture Capital Funding Global And Indian Experiences.
3	Stephen Bloomfield , Venture Capital Funding

Reference Book

1	Josh Lerner, Felda Hardymon and Ann Leamon, Venture Capital and Private Equity: A Casebook.
2	Robert Finkel , The Masters of Private Equity and Venture Capital.
3	Joseph. W. Bartlett , Fundamentals of Venture Capital

Assessment

Internal	40 %
Semester end	60%

Programme - Masters in Management Studies

Semester - III

SYSTEM (CORE)

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Database Management System & Data Warehousing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the introduction, Meaning and Definition of Database, Database Environment
2	To understand the Data Models : The importance of data models, Basic building
3	Understand applications of Database Management System(DBMS) & RDBMS
4	To understand the Object-Relational Database Management System(ORDBMS)
5	Overview of Structured Query Language and application DBMS to business

Prerequisites if any	Basic understanding of Database Management System
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Database Management System, RDBMS, Data Models, OODBM, SQL and its application to business.

Module

	Content	**Activity**	**Learning outcomes**
1	Introduction to Databases Introduction, Meaning and Definition of Database, Database Environment, Working of a Simple Centralized Database System, Tradition al File Systems vs. Modern Database Management Systems, Properties of Database, Types of Database Users, Advantages of using DBMS	Lecture	Understanding the basic DBMS concepts
2	Data Models: The importance of data models, Basic building blocks, Business rules, The evolution of data models Hierarchical, Network, Relational, Entity-Relationship model: entity and entity sets, relationship, constraints, E-R diagrams and issues.	Lecture & cases	Gaining an insight on various Data Models applied
3	Database Management System(DBMS) Basic concepts : data, information, metadata, definition of DBMS, Components, entities, attributes ,relationships, Data dependency Keys : Super key, Candidate key, Primary key, Alternate key, Foreign key Integrity Constraints: Entity Integrity, Referential Integrity ,DBMS three level(Logical, Conceptual, Physical) Advantages and disadvantages of DBMS, Database system environment and utilities	Lecture	Understand the concept of Primary Key and Foreign Key w.r.t DBMS Architecture

	Content	Activity	Learning outcomes
	Client/Server Architecture : two and three tier architecture		
4	Distributed Databases: Introduction to Distributed DBMS Concepts, Client-Server Model, Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design	Lecture and cases	Knowing about the Distributed Databases
5	Relational Database Management System (RDBMS): Definition, Meaning, and Introduction, Merits and demerits, Relational Database design: features of good relational database design, atomic Domain and Normalization (1NF, 2NF, 3NF, BCNF).	Lecture and cases	Understanding the concepts of RDBMS and Normalization Process
6	Object-Relational Database Management System(ORDBMS): Introduction, Basics of Object Oriented Design (OOD), Characteristics-Advantages-Object oriented development-Objects and Object classes-Object Oriented data Model, Object oriented databases, Object Relational Database Management Systems	Lecture & Cases	Understand the OOD w.r.t RDBMS and its advantages
7	Structured Query Language: SQL: Introduction, SQL, Multi table Queries, Nested Queries or Sub queries, Multiple Row Nested Queries, Data Manipulation Language, The Create Table Statement	Lecture & Cases	Application of SQL in DBMS
8	Security and integrity: Introduction, Security and Integrity Violations, Authorization, Granting of Privileges, Security Specification in SQL	Lecture & Cases	Gaining an insight on Database Security and User Rights
9	Datawarehousing, Multidimensional Data Models, Data Warehouse Architecture, ROLAP, MOLAP, HOLAP, OLAP and OLTP	Lecture & Cases	Understand the Concept of Data Warehousing
10	Data Mining, Data Preprocessing, Data Marts, Cluster Analysis, Decision Making.	Lecture & Cases	Understand the Concept of Data Mining and processing

Text books	
1	Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning.
2	Database management system by Navate
3	Database management by E.F Codd
4	Database Management Systems by Raghu Ramakrishnan
5	Introduction to Database Management Systems by Kahate

Reference books	
1	Database System and Concepts by A Silberschatz, H Korth, S Sudarshan, McGraw-Hill
2	Database Management Systems by P.S.Gill
3	Database System Concepts by Silberschatz
4	Database Management Systems by Bipin Desai
5	Principles of Database Systems by J.D.Ullman

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Enterprise Management Systems (EMS)**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Enterprise Resource Planning (ERP) - Meaning and Concept of ERP, Functional view of business processes and how they are integrated using an ERP, Merits and Demerits of ERP
2	To understand the Enterprise Content Management – Role of content management
3	To understand the applications areas of ERP, in various industry verticals and business
4	To understandEnterprise Portals – Concept of an enterprise portal
5	To understand the Enterprise Application Integration- Challenges in integrating

Prerequisites if any	Basic understanding of operations, framework of Enterprise Resource Planning (ERP)
Connections with Subjects in the current or Future courses	Will connect conceptual framework to the Enterprise Resource Planning (ERP) - Meaning and Concept of ERP, Functional view of business processes and how they are integrated using an ERP, Merits and Demerits of ERP

Module

S No	**Content**	**Activity**	**Learning outcomes**
1	Enterprise Management Systems – the Components – what is an Enterprise and its dynamics – how does it work. What subsystems are required to make it responsive and successful? How does IT play a part? Understanding Business IT.	Lecture and Caselets	Understand the role of Enterprise Management Systems in Business
2	Applications areas of an Enterprise viz. ERP, across various industry verticals and businesses such as BFSI, Retail, Telecom, Healthcare, across manufacturing and/or Marketing organizations, Government bodies etc...	Lecture	Gaining an insight on Applications of EMS in various industry verticals
3	Enterprise Content Management – role of content management – New Organization and Startup the challenges and Role of IT and systems Building Cashless and Process oriented organizations	Lecture	Gain an insight on role of content management, challenges w.r.t building cashless organizations

S No	Content	Activity	Learning outcomes
4	Enterprise Portals – Concept of an enterprise portal, benefits to an organization, Technologies available for building such portals.	Lecture Caselets	Understand the concept of Enterprise Portal and related Technologies
5	Enterprise Application Integration-Challenges in integrating various enterprise applications. Modern technologies for application integration.	Lecture and Enterprise cases	Identifying and solving the challenges in integrating various enterprise applications
6	Application Areas of ERP in SCM, and CRM, Supply Chain Management(SCM) – Need for Supply chain integration, Application overview of supply chain solution, advanced SCM and ERP integration	Lecture & Cases	Understanding the applications of ERP in SCM and logistics Management
7	Case Studies and Presentations – Case study to cover full enterprise layer with SCM, CRM and ERP combined with E-enabled organisation	Group Discussion and Individual assignments	

Text books	
1	Enterprise Resource Planning by Alexis Leon
2	Integrated Business Processes with Enterprise Systems by Simha Magal published by Wiley
3	Enterprise Systems for Management by Luvai Motiwalla and Thompson, published by Pearson
4	Enterprise Resource Planning by Mary Sumner published by Prentice Hall India
5	Enterprise Resource Planning by Makkar

Reference books	
1	Demos/Screen Shots of ERP Software such as SAP, CRM and SCM products
2	ERP Demystified by Alexis Leon
3	Enterprise Resource Planning Systems by Daniel O'Leary
4	ERP Systems by Batra and Srivastava
5	Work-study by ILO

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Big Data and Business Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Introduction to Big Data and Business Analytics and its applications
2	To understand the Business Analytics Cycle Introduction, Analytical Tools & Methods
3	To understand Data Mining & decision Making concepts, Predictive Analysis, Forecasting Optimization, Simulation, and Business Metrics tc.
4	To understand the Data Driven Prediction Methods NLP, Regression, Correlation, Cluster Analysis, Artificial Neural Networks, BI Tools & Applications

Prerequisites if any	Basic understanding of operations, framework
Connections with Subjects in the current or Future courses	Will connect conceptual framework to BigData and business Analytics.

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction to Data Analytics Need for Business Intelligence Data Management, Data Visualization, Data Warehousing, ETL Data Processing Chain From Business Intelligence to Business Analytics	Lecture	Understand the basic concepts of Big Data and Business Analytics
2	Business Analytics Cycle Introduction, Analytical Tools & Methods, Integration Social Analytics, Operational Analytics Big Data Analytics, Hadoop, Informatics, Cognos etc. Business application of big data analytics	Lecture & cases	Gain an insight on analytical tools and methods
3	Data Mining & decision Making Predictive Analysis Forecasting Optimization Simulation Gamification.	Lecture	Understand the predictive analytics and forecasting method w.r.t business analytics
4	Business Metrics in Action Data science in Startups Basics of Problem-Solving Design Patterns in Statistical Computing Excel for Data Science.	Lecture and cases	Gaining an insight on Business metrics and data science in statistical computing

Sr. No.	Content	Activity	Learning outcomes
5	Data Driven Prediction Methods NLP, Regression, Correlation, Cluster Analysis, Artificial Neural Networks, BI Tools &Applications.	Lecture and cases	Understand Statistical computing methods like NLP, regression and other BI tools
6	Case Studies and presentations	Lecture & Cases	

Text books	
1	Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses by Michael Minelli
2	Big Data & Analytics by Chellappan and Acharya
3	Big Data Analytics with R & Hadoop by Vignesh Prajapati
4	Big Data Analytics Made Easy by Y Lakshmi Prasad
5	Data Science for Business by Foster Provost & Tom Fowcett

Reference books	
1	Business Analytics: Data Analysis and Decision Making by S. Christian Albright
2	Big Data: Using Smart Big Data, Analytics and Metrics to Make Better Decisions and Improve Performance by Bernard Marr
3	Data Science and Big Data Analytics by EMC Education Services
4	Analytics in a Big Data World by Bart Baesens

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Knowledge Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the introduction to Meaning of data, information, knowledge
2	To Know the conceptual background and framework of KM
3	Understand the KM Foundations and Solutions KM Foundations
4	To know the Organizational Structure, Culture, Communities and KM practices, Information Technology as an enabler.

Prerequisites if any	Basic understanding of Knowledge Management
Connections with Subjects in the current or Future courses	Will connect conceptual framework to KM Infrastructure, Organizational Structure, Organizational Culture, Communities of Practice, Information Technology enabler

Module

	Content	**Activity**	**Learning outcomes**
1	Introduction to Knowledge Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge - Subjective & Objective views of knowledge, procedural Vs. Declarative, tacit Vs. Explicit, generals. Specific. Types of expertise – associational, theoretical Characteristics of knowledge – explicitness, teach ability, specificity Reservoirs of knowledge Locations and Intellectual Capital	Lecture	Understanding the KM concepts, types of knowledge and characteristics of knowledge
2	Introduction to Knowledge Management (KM) Meaning of KM, Relevance of KM in today's dynamic complex environment Forces Driving KM Organizational issues in KM Systems & their role Emergent KM practices Factors influencing KM Future of Knowledge Management	Lecture & cases	Basic concepts of knowledge management can be gained
3	KM Foundations and Solutions KM Foundations: Infrastructure, Mechanisms, Technologies KM Solutions and components: Processes (Discovery, Capture, Sharing, and Applications)Knowledge Utilization Process	Lecture	Km infrastructure, solutions and various components related to KM foundation can also be well understood and applied

	Content	Activity	Learning outcomes
4	KM Infrastructure Organizational Structure Organizational Culture Communities of Practice Information Technology enabler and Infrastructure Common Knowledge	Lecture and cases	Understanding the KM Structure, Organization Culture and Role of IT in facilitating the KM implementation.
5	Organizational Impact of KM Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency view Leadership and Assessment of KM Leadership , KM Assessment of Knowledge Management Solutions, Impacts Knowledge Workers Barriers to KM and IT Dissemination	Lecture and cases	Gain an Insight on KM dimensions, barriers and Performance factors w.r.t KM
6	Case studies and Application Exercises on KM processes	Lecture & Cases	

Text books	
1	Knowledge Management in Organizations by Donald Hislop, Oxford 2nd Edition.
2	Knowledge Management by Ganesh Natarajan and Sandhya Shekhar
3	Knowledge Management Systems Theory and Practice by Stuart Barnes (Ed.), Thomson Learning.
4	Knowledge Management, Shelda Debowski, Wiley India Edition.
5	Knowledge Management in Theory and Practice, Kimiz Dalkir, Elsevier, Butterworth Hinemann.

Reference books	
1	Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies. Prentice Hall. ISBN: 0-13-109931-0.
2	Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13-034820-1.
3	Ian Watson (2002). Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.
4	Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Software Engineering**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the in details software development process with issues /challenges In analysis, design, implementation ,maintenance etc.
2	Ability to analyze, design, verify, validate, implement, apply and maintain software systems.
3	To help students to develop skills that will enable to construct high quality software and reliability.
Prerequisites if any	Basic understanding of software Engineering
Connections with Subjects in the current or Future courses	Will connect conceptual framework to software engineering

Module

	Content	**Activity**	**Learning outcomes**
1	Exposure to software development process – Software Lifecycles such as Waterfall, Spiral, Prototyping, Rational Unified Process, Agile Methodologies – Various phases in each lifecycle model, and the pros and cons of these approaches to software development	Lecture	Understanding the software lifecycles and methodologies
2	Analysis and Design of Information systems •Assessing the Feasibility of a system •Gathering detailed requirement •Use of Structured methods such as Data flow, Entity Relationship diagrams etc – •Use of Object Analysis and Design •Use Cases and visualization of the IT based solution •Design of Inputs , Outputs and other interfaces	Lecture & cases	Gain an insight on analysis and designing of information systems Understand the use cases and e-r diagrams for process mapping
3	Documenting Software requirements - various documents used at different stages of software development process – User Requirement Specifications	Lecture	Understand the SRS designing and various stages involved in software development
4	Software Estimation – challenges in Estimation of software – methods of software estimation such as Line of Code, Function Point, COCOMO, COCOMO II, Use Case Point Method etc – Estimating a Coding Task versus non-coding activities such as Documentation etc	Lecture and cases	Gain an insight on cost estimation techniques for software development

	Content	Activity	Learning outcomes
5	Software Quality and Testing – Need for testing, Quality assurance of software at each phase in the lifecycle, Various types of tests such as Black box v/s White box, Functional test, code reviews , Stress tests, load tests etc Use of Use Cases for functional testing, Preparing Test Data and Test Cases, overview of Automated methods for testing	Lecture and cases	Understand the quality assurance and system testing w.r.t to software development. Learn to design the test case, apply test case and work on CASE tools
6	Review of Student Presentations on exercise which requires them to analyse a business process, requirements, documentation and maintenance, Analysis and Conceptual design of the system, estimation of the software size	Individual Assignment	
7	Case Studies and Presentations	Group Discussions and Workshops	

Text books	
1	Software Engineering- A Practioners's Approach", 7th Edition , Pressman
2	Analysis and Design of Information Systems, by James Senn, TMH
3	Raising Enterprise applications – A software engineering perspective by Pradhan, Nanjappa & Nallasamy
4	Fundamentals of Software Engineering by Rajib Mall
5	Software Engineering by Ian Sommerville

Reference books	
1	Structured systems analysis and design: concise study Ed 2, Kelkar SA. Published by PHI Learning, 2009, ISBN 10: 812032451X / ISBN 13: 9788120324510
2	OOAD – 3rd Edition, Booch and others, Addison Wesseley
3	Beginning Software Engineering by Rod Stephens
4	Software Engineering by Waman Jawadekar,Tata McGraw Hill

Assessment	
Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - III

SYSTEM (ELECTIVE)

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Cloud Computing & Virtualization**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Enabling Technologies and Cloud Computing Models including Infrastructure/Platform/Software
2	Understand the Cloud Operating System, Cloud Architectures including Federated Clouds ,Scalability, Performance, Quality of Service, Data centers for Cloud Computing
3	Principles of Virtualization platforms, Security and Privacy issues in the Cloud, Virtualization Techniques & Virtualization Technology
Prerequisites if any	Basic understanding of Cloud Computing & Virtualization
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Enabling Technologies and System Models for Cloud Computing , including benefits, challenges, and risks, Applications areas of business

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Enabling Technologies and System Models for Cloud Computing Introduction to Cloud Computing including benefits, challenges, and risks, Applications areas of business	Lecture	Understand the basic concepts of Cloud Computing
2	Cloud Computing Models including Infrastructure/Platform/Software – as-a-service, Public cloud, private cloud and hybrid	Lecture & cases	Gain an insight on Computing Models like IAAS, PAAS & SAAS
3	Cloud Operating System, Cloud Architectures including Federated Clouds	Lecture	Designing of Cloud Architecture can be well understood
4	Scalability, Performance, Quality of Service, Data centers for Cloud Computing	Lecture and cases	Need for Data Centers, Quality of Services etc. can be identified
5	Principles of Virtualization platforms, Security and Privacy issues in the Cloud, Virtualization Techniques & Virtualization Technology	Lecture and cases	Virtualization Concepts can be learnt and applied
6	VMWare ESX Memory Management, Capacity Planning and Disaster Recovery in Cloud Computing	Lecture & Cases	Understand the memory Management Capacity Planning and Disaster Recovery Techniques
7	Case Studies and presentations	Lecture & Cases	

Text books	
1	Cloud Computing: Fundamentals, Industry Approach and Trends by Rishabh Sharma
2	Cloud Computing First Steps: Cloud Computing for Beginners by Ravi Shankar and Navin Sabharwal
3	Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security by Kris Jamsa
4	Big Data Analytics with R and Hadoop by Vignesh Prajapati, 1st Edition, Shroff / Packt Publications

Reference books	
1	Cloud Computing Black Book by Kallakurchi, Houde, Shah
2	Cloud Computing: Principles and Paradigms by Rajkumar Buyya, Kames Broberg, Andrzej Goscinski
3	Cloud Computing from Beginning to End by Ray Rafaels
4	Cloud Security and Privacy by Mather Tim
5	Hadoop in Action by Chuck Lam Dreamtech Press Publisher.

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Information System Security and Audit**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Need for Information Security and Audit in an organization Identifying Information Assets in an organization
2	To understand the framework of Concept of Systems Audit
3	Understand the System & Infrastructure Maintenance
4	To Know the insights of Security Administration & Operations'
5	To understand the Global & Indian perspective
Prerequisites if any	Basic understanding of Information System Security and Audit
Connections with Subjects in the current or Future courses	Will connect conceptual framework to significance, Need for Information Security and Audit in an organization

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	The **latest opportunities in Information Systems Audit** Forensic accounting, Fraud prevention, Security in Business Information, Business Analytics, E-Commerce, Cloud computing, Big Data, Data Analytics, Social Media, etc.	Lecture	Understand the latest Opportunities in IT Audit
2	Need for establishing **Control Framework for information asset**, Understanding Information Risk Management and Control, Information Security (CIA) Management (Tools and techniques) for Safeguarding Business Information and related assets. General control – Preventive, Detective and Corrective Controls, Technological Controls - Application controls, Database controls and network controls, Administrative and Operational Controls – Physical, Environmental and Logical Controls. Importance of information security and audit	Lecture & cases	Understand the need for Control Framework Gain an insight on Business Information and related assets
3	**Concept of Information Systems and Security Audit Practices** Information System Audit - Planning, Conducting an audit, Reporting Audit findings, Audit Follow up. Information System Audit Function – Scope of Audit, Cycle Time, Audit Time and Cost effectiveness, Competency of an Auditor, Role responsibility and accountability of an IS Auditor, Internal and External Systems Auditor.	Lecture	Understand the IS Audit Practices

Sr. No.	Content	Activity	Learning outcomes
4	**Protection of Information / Application System** Review of business information / application flows in the organization, inputs, process, validation and output, modifications, authorizations, information (data) and application maintenance, disposal, etc. Review of database and data management systems Review of Logical access, Physical and Environmental controls that supports business information / application system.	Lecture and cases	Information Protection and Application Systems can be learnt and applied
5	**Protection of Information / Application Infrastructure** Network controls, Vulnerability Assessment and Penetration Testing, etc. Review of Logical access, Physical and Environmental controls that supports business information / application infrastructure.	Lecture and cases	Information Protection and Application Infrastructure w.r.t networks can be learnt and applied
6	**Business Continuity Management** (A Corrective Control as part of Contingency plan for Business IT) **Process -** Dependencies – External and Internal, Risk, Actions to address Risk, Performance Measurement, Improvement in resilience **BC Infrastructure** – Cold, Warm, Hot and Reciprocal Sites, Safety and Security of Business infrastructure, System and People **Practice** – BCM Team, Roles, responsibilities and authorities, Competencies, Awareness, Plans for Business Continuity and Disaster Recovery, Exercise and Testing, Management Reviews	Lecture & Cases	Business Continuity planning and implementation can be learnt
7	**Audit Tools and Certifications** Overview of COBIT 5 and its use by IS Auditors Overview of ISMS ISO 27001:2013 Overview of BCMS ISO 22301:2012 Certified Information System Auditor (CISA) Certified Information Security Manager (CISM) Certified In Governance of Enterprise IT (CGEIT) Certified in Risk & Information System Control (CRISC) Certified Information System Security Professional (CISSP)		Understand Auditing Tools, Career Option as IS Auditor and related Certifications
8	Case Studies and Presentations		

Text books

1	Information Systems Control and Audit – Ron Weber – Prentice Hall
2	Auditing in a computerized environment – Mohan Bhatia – Tata McGraw Hill
3	Information Security Principles and Practices – Mark Merkow and Jim Breithaupt – Pearson Education
4	IT Security Governance by IT Governance Institute (ITGI) BS:7799/ISO/IEC:17799
5	Information Systems Audit and Assurance by D.P Dube

Reference books

1	Information Systems Control & Audit – A Complete Reference by Dinesh Madan
2	Analysis and Design of Information Systems – V. Rajaraman – Prentice Hall of India Auditing - D.G–Prasuna – ICFAI Press
3	Understanding and conducting Information Systems Auditing by Hingarh and Ahmed, Wiley Corporate F&A
4	IT Audit Control and Security by Robert Moeller, Wiley Corporate F&A
5	Contemporary Auditing – Kamal Gupta – Tata McGraw Hill

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Data Mining and Business Intelligence**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Introduction to Data Mining: Introduction, Definition of Data Mining, Data mining parameters, How Data Mining works?,
2	To understand the framework of Classification on Data Mining system
3	Understandthe Data Mining Techniques: Introduction, Statistical Perspective on Data Mining, Statistics-need and algorithms.
4	Focus on Business Intelligence
5	To understand the Business Intelligence Essentials

Prerequisites if any	Basic understanding of Data Mining and Business Intelligent
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Architecture of Data Mining, Kinds of Data which can be mined, Functionalities of Data Mining and business intelligent

Module

	Content	**Activity**	**Learning outcomes**
1	Introduction to Data Mining: Introduction, Definition of Data Mining, Data mining parameters, How Data Mining works?, Types of relationships, Architecture of Data Mining, Kinds of Data which can be mined, Functionalities of Data Mining,	Lecture	Understand the Data Mining Concepts
2	Classification on Data Mining system, Various risks in Data Mining, Advantages and disadvantages of Data Mining, Ethical issues in Data Mining, Analysis of Ethical issues, Global issues	Lecture & cases	Gain an insight on Ethical issues related to Data mining
3	Data Mining Techniques: Introduction, Statistical Perspective on Data Mining, Statistics-need and algorithms.	Lecture	Understand the application of Data Mining Techniques
4	Business Intelligence an Introduction: Introduction, Definition, History and Evolution, Business Intelligence Segments, Difference between Information and Intelligence, Defining Business Intelligence Value Chain, Factors of Business Intelligence System, Real time Business Intelligence, Business Intelligence Applications	Lecture and cases	BI Concepts and Background can be well understood
5	Business Intelligence Essentials: Introduction, Creating Business Intelligence Environment, Business Intelligence Landscape, Types of Business Intelligence, Business Intelligence Platform, Dynamic	Lecture and cases	Essentials for BI Implementation can be learnt

	Content	Activity	Learning outcomes
	roles in Business Intelligence, Roles of Business Intelligence in Modern Business-Challenges of BI		
6	Business Intelligence Types: Introduction, Multiplicity of Business Intelligence Tools, Types of Business Intelligence Tools, Modern Business Intelligence, the Enterprise Business Intelligence, Information Workers	Lecture & Cases	Gaining an insight on BI tools w.r.t Modern Business Technology
7	Business Intelligence Life Cycle: Introduction, Business Intelligence Lifecycle, Enterprise Performance Life Cycle (EPLC) Framework Elements, Life Cycle Phases, Human Factors in BI Implementation, BI Strategy ,Business Intelligence Issues and Challenges: Introduction, Critical Challenges for Business Intelligence success	Lecture & Cases	Understand BI life cycle and framework , issues and implementation challenges
8	Application of Business Intelligent and Data Mining for Business	Lecture & Cases	Gain Insight on BI Application and Data Mining
9	Case Study and Application		

Text books	
1	Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", G. Shmueli, N.R. Patel, P.C. Bruce, Wiley India
2	Introduction to DATA MINING with CASE STIDIES BY G K GUPTA
3	Introduction to Data Mining by Tan, Kumar published by Pearson
4	Data Mining Concepts and Techniques by Vikram Pudi & Radha Krishna, Oxford University Press
5	Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis

Reference books	
1	Data Mining Concepts and Techniques by Han
2	Modern Data Warehousing, Mining and Visualization by George Marakas, Pearson
3	Data Mining – Principles and Applications by Kumar, Elsevier
4	Data Mining for Managers by Richard Boire, Palgrave Macmillan
5	Data Mining for Dummies by Meta Brown , John Wiley and Sons

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**IT Consulting**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Data warehousing Components –Building a Data warehouse
2	To understand the framework of The Structure of the Data Warehouse, Granularity
3	To understand the Normalization and denormalization Triggering the Data Warehouse Record
Prerequisites if any	Basic understanding of Advances Database and Data Warehousing
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Data warehousing Components –Building a Data warehouse , to connect to applications of data warehousing

Module

	Content	**Activity**	**Learning outcomes**
1	Introduction to Consulting, types of Consulting, Professional Consulting, Trends in Consulting Industry	Lecture	Gain insight on IT Consulting Concepts
2	Discussion on Data Gathering Methods, Contracting, Proposal Writing, Data Handling & Analysis	Lecture, cases and Class research	Understand various data gathering methods and contracting formalities
3	Introduction to IT Consulting, History of IT/IS/ITES Consulting, Various IT Services, IT Value Chain, Drivers of Future Growth	Lecture	Understand the IT Value Chain, Drivers for Future Business Growth
4	Consulting roles and growth cycle of the individual consultant Consulting to CIO/CTO/CEO & Boards, Various consulting services to CEOs and Boards of Directors, Understanding the diversity of consulting roles ,Consulting to the Board: unique process issues and transformation challenges	Lecture and cases	Gain insight on Various Consulting Services offered and understanding the consultants role
5	Consulting to Global Clients, Growth in Global Consulting, 9-Step Framework for Analysis, Diverse Issues in Global Consulting	Lectures and class research	Understand Global Consulting Framework and Global Challenges
6	Identifying and Deciding on Alternatives for Action and Measurement: Managing Consulting Firms - The Knowledge Sharing Problem, Consulting as a Profession - Marketing and Selling of Consulting Services - Strategic and Organization	Proposal writing and Case study	Learn to Identify alternatives for action and measurement, managing consulting firms

	Content	Activity	Learning outcomes
	Information Technology Consulting, Client-consultant relationship, internal vs. External, service Quality		

Text books	
1	High Value IT Consulting by Purba and Delaney published by McGraw-Hill
2	Million Dollar Consulting Proposals by Alan Weiss published by Wiley
3	IT Consulting Essentials – A Professional Handbook by Dave Faulise
4	The Art of IT Consulting by Biswo Samal

Reference books	
1	The Nomadic Developer by Aaron Erickson published by Pearson Education
2	How to Star and Run IT Consultancy Business by Srikanth Merianda and Brandi Marcene
3	The IT Consultant by Rick Freedman, John Wiley and Sons
4	Consulting – A Practitioners Perspective by Mohan Kancharla, Notion Press

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Digital Business**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Introduction to Digital Business ,framework of Drivers of digital business-, Mobile, Cloud Computing, Social media
2	To understand the E-Business- Meaning, Retailing in e- Business-products and services, consumer behavior
3	Developing the Digital Business Support services- e-CRM, e-SCM, e-banking, ERP, Mobile Computing
4	To know about -Building Digital business Applications and Infrastructure, IAAS, SAAS, PAAS, Information Super Highway, Collaboration Tools

Prerequisites if any	Basic understanding of digital business
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Background and current status ,E-market places, structures, mechanisms, economics , to know the difference between physical economy and digital economy

Module

	Content	**Activity**	**Learning outcomes**
1	Introduction to Digital Business Introduction, Background and current status ,E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy	Lecture	Understand the Concepts of Digital Business
2	Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business	Lecture & cases	Gain insight on the drivers of digital business
3	Overview of E- Business E-Business- Meaning, Retailing in e- Business-products and services, consumer behavior, market research and advertisement B2B-E- Business-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, mobile commerce and pervasive computing	Lecture	Understand various e-business models
4	Digital Business Support services- e-CRM, e-SCM, e-banking, ERP as e –business backbone, Mobile Computing	Lecture and cases	E-Business Support Services can be learnt
5	Understanding -Building Digital business Applications and Infrastructure, IAAS, SAAS, PAAS, Information Super Highway,	Lecture and cases	Understand the Digital Business Infrastructure and Challenges

	Content	Activity	Learning outcomes
	Collaboration Tools		
6	Managing E-Business-Managing Knowledge, Management skills for e-business, Launching a successful online business and E - Business project, Legal, Ethics and Societal impacts of E- Business , Managing Risks in e –business Security Threats to e-business -Security Threats, Encryption, Cryptography, Digital Signatures, Digital Certificates,	Lecture & Cases	Understand the Security, ethics and societal impact of digital business
7	E-Business Strategy- E- Business Strategy and Implementation, E Business strategy and global E- Business, Economics and Justification of E-business ,Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition	Lecture & Cases	Gain an insight on E-business strategy formulation
8	Case Studies and presentations	Lecture & Cases	

Text books	
1	Digital Business Concepts and Strategy –Eloise Coupey, 2nd Edition –Pearson
2	Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
3	Digital Business and E-Commerce Management, 6th edition –Dave Chaffey, August 2014
4	Digital Strategy – A guide to Digital Business Transformation by Alexander Rauser
5	Trend and Challenges in Digital Business Innovation –Authors –Vinocenzo Morabito, Italy-Springer

Reference books	
1	A textbook on E-commerce - Publisher: Neha Publishers & Distributors
2	E-commerce from vision to fulfilment-Elias M. Awad PHI-Restricted (2002)
3	Introduction to E-business-Management and Strategy-Colin Combe, ELSVIER, 2006
4	Leading Digital – Turning Technology into Business Transformation by HBR
5	Perspectives the Digital Enterprise –A framework for Transformation –TCS consulting journal Vol.5

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Software Project management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Introduction, the state of IT project management, need of project management, project goals, project life cycle and IT development
2	To understand the project management process, project integration Management, the project charter, project planning framework, the contents of a project plan, the planning process.
3	Understand the Introduction, developing the project schedule, project management software tools, methods of budgeting, developing the project budget, improving cost estimates, finalizing the project
4	To know the Organization and project planning, the project team, the Project environment.
5	To understand the Managing Project Procurement and Outsourcing , project procurement management, outsourcing.

Prerequisites if any	Basic understanding of software project management
Connections with Subjects in the current or Future courses	Will connect to the software project management issues and challenges ,implementation Plan, project evaluation, project audit closure, outsourcing

Module

	Content	**Activity**	**Learning outcomes**
1	An overview of IT Project Management - Introduction, the state of IT project management, need of project management, project goals, project life cycle and IT development, extreme project management, PMBOK. IT Project Methodology ITPM), project feasibility, request for proposal (RFP), the business case, project selection and approval, project contracting, IT governance.	Lecture	Gain an insight on overview of software project management
2	Introduction, project management process, project integration Management, the project charter, project planning framework, the contents of a project plan, the planning process. The Work Breakdown Structure (WBS), the linear responsibility chart, Multidisciplinary teams.	Lecture & cases	Understand the WBS and Project Planning concepts
3	Introduction, developing the project schedule, project management software tools, methods of budgeting, developing the project budget, improving cost estimates, finalizing the project schedule and budget. IT project risk management planning process, identifying IT project risks, risk analysis and assessment, risk strategies, risk monitoring and control, risk	Lecture	Understand the Software tools, risks involved and its assessment

	Content	Activity	Learning outcomes
	responses and evaluation		
4	The Human Side of Project Management- Introduction, Organization and project planning, the project team, the Project environment. The Project Communication, monitoring and controlling the project, the project communications plan, project metric, project control, plan monitor control cycle, , reporting performance and progress, Project Leadership and Ethics- Introduction, project leadership, ethics in projects, multicultural projects. Managing Change, Resistance and Conflicts	Lecture and cases	Gain Insight on Project team, Leadership, Roles, Conflicts multi-cultural projects
5	Managing Project Procurement and Outsourcing Introduction, project procurement management, outsourcing.	Lecture and cases	Project procurements and outsourcing can be learnt
6	The Implementation Plan and Project Closure- Introduction, project implementation, administrative closure, project evaluation, project audit.	Lecture & Cases	Understand the implementation plan and project closure
7	Case Studies and presentations	Lecture & Cases	

Text books	
1	Joel Henry, "Software Project Management, A real world guide to success", Pearson Education, 2008.
2	Hughes and Cornell, "Software Project Management", 3rd edition, Tata McGraw Hill
3	Information Technology Project Management", Jack T. Marchewka, 3rd edition, Wiley India, 2009.
4	Joseph Phillips, "IT Project Management", 2nd edition, Tata McGraw Hill
5	Software Project Management – A Concise Study by Kelkar

Reference books	
1	S. J. Mantel, J. R. Meredith and etl..."Project Management" 1st edition, Wiley India, 2009.
2	John M. Nicholas, "Project Management for Business and Technology", 2nd edition, Pearson Education.
3	Dinsmore, P. C. (Ed.). (1993) The AMA Handbook of Project Management. AMACOM
4	Robert K. Wyzocki and Rudd McGary, "Effective Project Management", 3rd edition, Wiley Brown, K.A. Project Management, McGraw Hill, 2002.
5	Mastering IT Project Management, Practices, Tools and Techniques by Murali Chemuturi

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Governance of Enterprise IT & Compliance**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Need for IT Governance (COBIT Framework)Importance and need of IT Governance and Compliances to know the laws , norms like IT Act, Sarbanes Oxley and the Graham
Prerequisites if any	Basic understanding of IT Governance and Compliance
Connections with Subjects in the current or Future courses	Will connect to Overview of various Standards and governance framework Introduction to the COBIT Framework as an umbrella Framework and various norms and acts.

Module

	Content	**Activity**	**Learning outcomes**
1	**Governance of Enterprise IT and IT Governance** **GEIT Benefits** – Cyber security, Privacy concerns, Multiple frameworks, Resource utilization, Industry specific issues, External Partners, Multiple Agendas, and Disruptive Technologies.	Lecture / Group Discussion / Workshop	Understand concepts on Governance of Enterprise IT and Management of Enterprise IT.
2	**Compliance** Compliance to Process Standards - ISO/IEC 38500, PRINCE2 /PMBOK, TOGAF9, ISO/IEC 31000, ISO/IEC 27000, CMMI, ITIL V3 AND ISO/IEC 20000. Compliance to Legal and Regulatory Requirements - IT Act, Sarbanes Oxley Act, Safe Harbor, Graham Bleach Act, RBI and other Banking Regulations and Basel III (for Banks), Data Privacy Act (PIMS), Data Protection Act, etc.	Lecture / Group Discussion / Workshop	Understand and comply with sample Process standards, Legal and Regulatory requirements.
3	**Implementing GEIT** – Initiate program (*Establish desire to change- recognize need to act*), Define problems and opportunities (*form implementation team-assess current state*), Define Road Map (*Communicate outcome-define target state*), Plan Program (*Identify role players- build improvements*), Execute Plan (*Operate and use-implement improvements*), Realize Benefits (*Embed new approaches-Operate and measure*), and review effectiveness (*Sustain– Monitor and Evaluate*).	Lecture / Group Discussion / Workshop	Understand the use of COBIT for assessing the maturity level of Governance and Management of Enterprise IT.
4	**COBIT5 Framework and relative**		Understand COBIT5

	Content	Activity	Learning outcomes
	coverage with other Standards – ISO/IEC 38500, PRINCE2 /PMBOK, TOGAF9, ISO/IEC 31000, ISO/IEC 27000, CMMI, ITIL V3 AND ISO/IEC 20000.		as a Tool to implement GEIT
5	Case Studies and Presentations	Group Discussion / Workshop	

Text books	
1	COBIT 3.0/4.0 – IT Governance Institute
2	BS – 7799 – IT Security Standards
3	Appropriate Standards like Sarbanes Oxley
4	IT Act 2000
5	A Primer for Implementing Governance of Enterprise IT – ISACA
6	A business framework for the Governance and Management of Enterprise IT – COBIT5 – ISACA
7	IT Governance – AN Introduction by Ravi Kumar Jain Banda, ICFAI University Press
8	IT Governance by Weill and Ross, HBR Press

Reference books	
1	ISO/IEC 38500:2008 Corporate Governance of Information Technology Principles and Practices (Evaluate Direct and Monitor)
2	Governance of the Extended Enterprise – IT Governance Institute – Wiley
3	Introduction to Information Security ad ISO 27001- A Pocket Guide by Watkins, It Governance Publishing
4	IT Governance – Guidelines for Directors by Alan Calder by IT Governance Publishing
5	Governance, Risk Management and Compliance by Richard Steinberg, Wiley Corporate F&A

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Cyber Law & Managing Enterprise IT Risk**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Basic Concepts of Technology and Law and Law of Digital Contracts :
2	Understand Intellectual Property Issues in Cyber Space
3	To know the insights to Rights of citizens and E-Governance
4	To get aware the Information Technology Act 2000 , Understanding Enterprise IT Risk

Prerequisites if any	Basic understanding of cyber law
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Basic Concepts of Technology and Law : Understanding the laws relating Technology of Internet, Cyber Laws, Cyber Jurisprudence and scope

Module

	Content	**Activity**	**Learning outcomes**
1	Basic Concepts of Technology and Law : Understanding the Technology of Internet, Scope of Cyber Laws, Cyber Jurisprudence	Lecture	Understanding the concept of Cyber laws
2	Law of Digital Contracts : The Essence of Digital Contracts, The System of Digital Signatures, The Role and Function of Certifying Authorities, The Science of Cryptography	Lecture & cases	Gain Insights on Digital Signatures, Certifying Authorities, Cryptography
3	Intellectual Property Issues in Cyber Space: Copyright in the Digital Media, Patents in the Cyber World.	Lecture	Understand IPR Issues and Digital Media Rights
4	Rights of citizens and E-Governance : Privacy and Freedom Issues in the Cyber World, E-Governance, Cyber Crimes and Cyber Laws	Lecture and cases	Gain Insight on Rights of Citizens and e-governance
5	Information Technology Act 2000 : Information Technology Act-2000-1 (Sec 1 to 13), Information Technology Act-2000-2 (Sec 14 to 42 and Certifying authority Rules), Information Technology Act-2000-3 (Sec 43 to 45 and Sec 65 to 78), Information Technology Act-2000-4(Sec 46 to Sec 64 and CRAT Rules), Information Technology Act-2000-5	Lecture and cases	Understand the IT Act 2000 Understand the Sections. Penalties related to various Cyber crimes

	Content	Activity	Learning outcomes
	(Sec 79 to 90), Information Technology Act-2000-6 (Sec 91-94) Amendments in 2008.		
6	International Scenario in Cyber Laws: Data Protection Laws in European Union (EU) and USA, Child Abuse Protection Laws in EU and USA, Cyber Laws - the Malaysian Approach.	Lecture & Cases	Understand the Global Cyber Security Standards
7	Cyber Law Issues for Management :Cyber Law Issues in E-Business Management, Major issues in Cyber Evidence Management, Cyber Law Compliancy Audit	Lecture & Cases	Understand the ways and means of evidence collection & Auditing Standards
8	**Management of Enterprise IT Risk** **IT Risk Identification:** Identify the universe of IT risk to contribute to the execution of the IT risk management strategy in support of business objectives and in alignment with the enterprise risk management (ERM) strategy **IT Risk Assessment:** Analyse and evaluate IT risk to determine the likelihood and impact on business objectives to enable risk-based decision making. **Risk Response and Mitigation:** Determine risk response options and evaluate their efficiency and effectiveness to manage risk in alignment with business objectives. **Risk and Control Monitoring and Reporting:** Continuously monitor and report on IT risk and controls to relevant stakeholders to ensure the continued efficiency and effectiveness of the IT risk management strategy and its alignment to business objectives.		Understand the concepts of IT Risk Gain insights on IT risk assessments, Mitigation techniques Learn the Risk and Control Monitoring and Reporting Process
9	Case Studies and Presentations	Lecture & Cases	

Text books	
1	Peter Weill , Jeanne Ross “IT Governance: How Top Performers Manage IT Decision Rights for Superior Results”
2	Cyber Laws in India by Satish Chandra
3	Cyber Laws and IT Protection by Harish Chander, PHI Publisher
4	Textbook of Cyber Law by Pavan Duggal, Universal Law Publishing
5	Information Technology Law and Practice by Vakul Sharma
6	Cyber Laws – Indian and International Perspectives by Aparna Vishwanathan

Reference books	
1	Jeanne W. Ross “Enterprise Architecture As Strategy: Creating a Foundation for Business Execution”
2	Peter Weill “IT Savvy: What Top Executives Must Know to Go from Pain to Gain
3	ISO/IEC 31000 and ISO/IEC 27005 Risk Management Standards
4	Computer Internet and New Technology Laws by Karnika Seth
5	Data Protection in India by Pavan Duggal

Assessment	
Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - III

HRM (CORE)

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Training & Development**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1.	Learning the intricacies of process of training and development and audit

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr No	Content	Activity	Learning Outcome
1	Introduction to human resource development	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to the concept of human resource development
2	Overview of Training in Organizations □ Role of training □ structure of training Planning for Training and Development □ Management of Training function □ Need assessment □ Evaluation □ Organization of Training	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to training, structure, need assessment and evaluation of training
3	Learning organization	Case Study/ Role-play/ Drama/ Group Discussion	Exploring the concept of learning organization
4	□ Principles of Adult Learning □ Learning Styles □ Self Generated Learning □ Experiential Learning □ Motivation & Performance	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to adult learning and different methodologies
5	Training Administration. □ training budget , □ budget training	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to preparation of training budget, calendar and training modules.

Sr No	Content	Activity	Learning Outcome
	programmes, design training calendar /schedules) Designing and executing Training inputs Establishing Learning Objectives Developing Training Modules Role of 'Active Training'		
6	Training Need assessment	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the process of training needs assessment
7	Competency modeling and mapping	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the method of competency modeling and mapping
8	Designing Training Modules	Case Study/ Role-play/ Drama/ Group Discussion	Learning to design training module
9	Implementation of Training	Case Study/ Role-play/ Drama/ Group Discussion	Learning methods of implementing training
10	Traditional training methods E-learning and use of technology in training Computer Based Training Satellite Based Training Outbound Training Fusion Methodology: Theatre, Art, Music as methodologies The World as a Classroom	Case Study/ Role-play/ Drama/ Group Discussion	Exploring various types of training
11	Training evaluation, Cost Benefit Analysis and ROI	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to training evaluation, cost benefit analysis and ROI
12	Management Development.	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to management development
13	Planning & Organizing conferences, seminar etc Training Audit.	Case Study/ Role-play/ Drama/ Group Discussion	Methods of Planning & Organizing conferences, seminar etc Introduction to Training Audit.

Sr No	Content	Activity	Learning Outcome
14	Case Studies and Presentations	Case Study/ Role-play/ Drama/ Group Discussion	

Reference books

1	Effective Training Systems, Strategies and Practices P. Nick Blanchard, James W Thacker second edition Pearson Education
2	P. Nick Blanchard, James W Thacker second edition Pearson Education

Text books

1	Employee Training and Development by Raymond A Noe, 3ed. McGraw Hill Publication (International Edition)

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Compensation and Benefits**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1.	To understand the concept of compensation, various elements, inflation, laws related to compensation, variable pay and income tax

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning Outcome
1	Human Resources Philosophy and Approach for an Organization	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to the philosophy of human resources
2	Reward Strategies – Articulating and understanding business context for reward strategies	Case Study/ Role-play/ Drama/ Group Discussion	Understanding business context for reward strategies and preparing strategies
3	Elements of Reward Strategy – Understanding Reward Management	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the elements of reward strategy and management
4	Compensation / Remuneration place in Reward Strategy	Case Study/ Role-play/ Drama/ Group Discussion	Exploring Compensation / Remuneration place in Reward Strategy
5	Understanding Elements of Compensation Structure □ Fixed , □ Cash Benefits, □ Retirals and □ Social Security, □ Variable Pay / Incentives / Stock Options	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Elements of Compensation Structure
6	Costing the CTC of each element of Compensation Structure (excluding stock options)	Case Study/ Role-play/ Drama/ Group Discussion	Learning to Cost the CTC of each element of Compensation Structure

Sr. No.	Content	Activity	Learning Outcome
7	Understanding Inflation – Neutralization of Inflation – Dearness Allowance Consumer Price Indices	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the concept of Inflation
8	Understanding Provident Fund, ESIC, Gratuity, Superannuation, Bonus under Payment of Bonus Act	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Provident Fund, ESIC, Gratuity, Superannuation, Bonus under Payment of Bonus Act
9	Types of Variable Pay	Case Study/ Role-play/ Drama/ Group Discussion	Learning various types of Variable Pay
10	Understanding Income Tax	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Income Tax
11	Arriving at the CTC of an employee/ candidate – costing elements, designing a salary offer template Making a salary offer to a candidate – understanding salary ranges	Case Study/ Role-play/ Drama/ Group Discussion	Preparing the CTC of an employee
12	Remuneration Survey- choosing a partner, conducting a survey, benchmarking, arriving at a comparator, target position, understanding median , percentile, ageing of market data Converting Remuneration Survey results into a Salary Proposal	Case Study/ Role-play/ Drama/ Group Discussion	Learning the details of remuneration survey
13	Equity Compensation Plans objective of equity compensation, types of Stock Plans, Valuing stock grants, SEBI Guidelines, taxability of stock options	Case Study/ Role-play/ Drama/ Group Discussion	Learning the intricacies of equity compensation plans

Sr. No.	Content	Activity	Learning Outcome
14	Case Studies and Presentations	Case Study/ Role-play/ Drama/ Group Discussion	

Reference books

1	Textbook of HRM – P. Subha Rao.
2	Managing Human Resources – Bohlander, Snell, Sherman
3	Compensation Management – Dipak Kumar Bhattacharya – Oxford Publications

Text books

1	Compensation Management in a Knowledge Based World – Richard I Henderson – Pearson Publications

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Competency Based HRM and Performance Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To provide both theoretical and application-oriented inputs on competency mapping and developing mapped competencies.
2	To understand the concept of competency and competency based HR practices.
3	To understand the various approaches towards building a competency model
4	To understand how to integrate the applications of competency model with other HRM functions.
5	To impart the understanding about the Performance Management system and strategies adopted by the Organizations

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Concept and definition of Role and competency**. History of competency, Types of competencies – generic/specific. Competency description, Competency levels, Designing competency dictionary, Why to promote a competency culture, Context and Relevance of competencies in modern organizations Evolution of Competency based HRM, Competency Selection; Competency based Training & Development. Competency Based Performance Management; Competency Based Career & Succession Planning, linking HR processes to organizational strategy, competency framework – development of personal competency framework, Developing Competency Models ,Issues relating to Competency models.	Case Studies, Class Discussions, Assessment Centre exercises, Field Project, Presentations, Practical Examples Assignments	Basic Understanding concept of Competency and its relevance to modern day Organizations.

Sr. No.	Content	Activity	Learning outcomes
2	**Methods of Data Collection for Mapping:- .** Observation b. Repertory Grid c. Critical Incidence Technique d. Expert Panels e. Surveys , Job Task Analysis h. Behavioral Event Interview, i. use of technology. Developing Competency Models from Raw Data: a. Data Recording b. Analyzing The Data c. Content Analysis of Verbal Expression d. Validating the Competency Models	Case Studies, Class Discussions, Assessment Centre exercises, Field Project, Presentations, Practical Examples Assignments	Gaining knowledge about the various methods of data collection in mapping process and knowledge of validating the Competency model.
3	**Competency Mapping and Assessment** – Meaning, purpose and Benefits, Steps in Competency Mapping –, Measuring and mapping competencies a. BEI b. Assessment centre c. Conducting and operating assessment centre d. Role of assessors in an assessment centre e. Designing tools in an assessment centre f. Integration of data , Report Writing and g. Feedback mechanism . Approaches to Mapping	Case Studies, Class Discussions, Assessment Centre exercises, Field Project, Presentations, Practical Examples Assignments	Knowledge about running the assessment centre and Report writing and learning about how to give feedback.
4	**Conceptual Framework of Performance Management** Performance Management process; Objectives of Performance Management system; Historical development in India; Performance management and Performance appraisal; Linkage of Performance Management system with other HR practices. Components of Performance Management System: Performance planning; Ongoing support and coaching; Performance measurement and evaluation.	Case Studies, Class Discussions, Assessment Centre exercises, Field Project, Presentations, Practical Examples Assignments	Learning about the conceptual frame work of Performance Management System and its linkage with HR practices
5	Implementation and Issues in Performance Management: a. Defining Performance b. Determinants of Performance c. Performance Dimensions d. Approaches to Measuring Performance e. Diagnosing The Causes of Poor Performance f. Differentiating Task from Contextual Performance	Case Studies, Class Discussions, Assessment Centre exercises, Field Project, Presentations, Practical Examples Assignments	Learning about the Implementation of Performance Management System, issues and challenges

Sr. No.	Content	Activity	Learning outcomes
	g. Choosing a Performance Measurement Approach. h. Measuring Results and Behaviors i. Gathering Performance Information j. Implementing Performance Management System		
6	Performance Management and Employee Development: a. Personal Development Plans b. 360 Degree Feed Back as a Developmental Tool c. Performance Management and Reward System d. Performance Linked Remuneration System e. Performance Linked Career Planning and Promotion Policy	Case Studies, Class Discussions	Studying performance management as a tool for employee development
7	Conducting Staff Appraisals a. Introduction & Need b. Skills Required c. The Role of The Appraiser d. Job Description and Job Specification e. Appraisal Methods f. Raters Errors g. Data Collection h. Conducting an Appraisal Interview i. Follow Up and Validation	Case Studies, Class Discussions	Understanding the process of conducting staff appraisal
8	Performance Consulting: a. Concept b. The Need for Performance Consulting c. Role of The Performance Consulting d. Designing and Using Performance Relationship Maps e. Contracting for Performance Consulting Services f. Organizing Performance Improvement Department	Case Studies, Class Discussions	Understanding performance consulting
9	Reward for Performance: a. Reward System, Components of Reward System, b.Objective of Reward System, Linkage of performance management to reward and compensation System Performance Management Pitfalls and	Case Studies, Class Discussions	Study of rewards for performance

Sr. No.	Content	Activity	Learning outcomes
	Remedies, c.Recognizing the problems and Pitfalls, Limitations, Shortcoming or efficiencies of performance appraisal, Guideline for performance appraisal and good practices		
10	Ethics in Performance Management: a.Ethical Performance Management Defined, Objectives and Significance of Ethics in performance Management, b.Ethical issues and dilemmas in Performance Management, Ethical Strategies in Performance management, Performance Management in Multinational Corporations	Case Studies, Class Discussions	Overview of ethical practices in performance management
11	Case Study and Presentations		

Text books

1	Armstrong, M. & Baron, A., Performance Management and development, Jaico Publishing House, Mumbai.
2	Armstrong, M., Performance management: Key strategies and practical guidelines, Kogan Page, London.
3	Bagchi, S. N., Performance management, Cengage Learning India
4	Bhattacharyya, D.K., Performance management systems and strategies, Pearson Education

Reference books

1	Seema Sanghi: 'Handbook of Competency Mapping'; Response Books; Latest Edition
2	Ganesh Shermon: 'Competency based HRM'; Tata McGraw Hill; Latest Edition.
3	Whiddett and Hollyforde: 'A Practical Guide to Competencies'; Chartered Institute of Personnel and Development; Latest Edition.

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Labour Laws and Implications on Industrial Relations**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Understanding Nature and Importance of Labour Laws
2	To understand various legislations with their history, basic provisions & case laws
3	To study current amendments in Labour laws
4	Highlight Labour Laws with IR implications

Module

Sr. No.	Content	Activity	Learning outcomes
1.	**Overview of IR** • IR history in brief, System approach to IR and IR model, • Collective Bargaining, Basic Grievance machinery and disciplinary procedure • Importance of Workers Participation in Management with few egs. • Relating IR to labor laws • Labor laws with IR implications for futuristic India		This is to give a snapshot of IR and the faculty to relate importance of IR to Labor Laws, changing dynamics of IR
2	**Introduction to Labor Laws** • Government of India Structure, Constitutional provisions for labor • Structure of Courts and appropriate authorities in India. • Principles of Labor Laws Classification of Labor Laws viz: Regulative, Employment, Wage, • Social Security & IR		Understanding court jurisdictions and basics of labor laws
3	**Industrial Relations Legislations** • Industrial Dispute Act 1947 • Trade Union Act 1926 &	Case Laws	To study history, provisions, case laws & amendments under each law.

Sr. No.	Content	Activity	Learning outcomes
	MRTUP & PULP 1971 (only unions politics & recognition provision) • Industrial Employment (Standing Order) Act 1946		
4	**Regulative Laws** • The Factories Act, 1948 • The Bombay Shop and Establishment Act, 1948	Case Laws	To study history, provisions, case laws & amendments under each law.
5	**Social Security Legislations** • Workmen's Compensation Act 1923 (with sums) • ESI Act 1948 • Gratuity Act 1972 • Provident Fund Act & Mis. 1952	Case Laws	To study history, provisions, case laws & amendments under each law.
6	**Wage Legislations** • Payment of Wages Act 1936 • Minimum Wages Act 1948	Case Laws	To study history, provisions, case laws & amendments under each law.
8	**Overview of few laws** • Maternity Benefit Act 1961 • Apprentice Act 1961 • Employment Exchange Act 1951 • Payment of Bonus Act 1965	Case Laws	Just an overview needs to be taught
9.	Internal Assessments Overview of Alternate Dispute Resolution Mechanisms		
10.	Revision		

Text and Reference books

1	Mamoria, C. B. & Mamoria, S. Dynamics of Industrial Relations in India. Himalaya Publishing House
2	Sharma, A. M. Industrial Relations: Conceptual & Legal Framework. Himalaya Publishing House
3	Mamoria, C. B., Mamoria, S. & S. V. Gankar. Dynamics of Industrial Relations in India. Himalaya Publishing House
4	Sharma, A. M. Industrial Relations: Industrial Jurisprudence and Labour Legislation. Himalaya Publishing House
5	Kapoor, N.D: Elements of Mercantile Law. Sultan Chand & Sons

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Human Resource Planning and Application of Technology in HR**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

	To understand the concept of HR Planning and application of technology in HR

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

S. No.	Content	Activity	Learning Outcome
1	**Human Resource Planning** Meaning, The planning process. Indicators and trends. Ascertaining demand and supply in human resource. Causes of demand, forecasting techniques and human resource requirements. Estimation of internal supply and external supply. Linking human resource planning with strategic human resource management.	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to HR Planning and forecasting
2	**Job Analysis, HR Planning and Selection in the Modern Business Environment:** Job analysis and design, Collection and application of job analysis information, alignment of job analysis to selection. Changing perspectives in the field of recruitment and selection in the information age: e-recruitment and selection. **Employment Tests:** Concepts of Testing, Types of tests, Executive Talent Search .	Case Study/ Role-play/ Drama/ Group Discussion	Learning the concept of job analysis and selection

S. No.	Content	Activity	Learning Outcome
3	**Workforce Diversity,** Diversity Planning, Dimensions of Diversity, Policies, Valuing Diversity in Organizations, Gender Diversity Legislation, Corporate initiatives on Gender Diversity. Organizational Strategies for Promoting Diversity, Diversity Awareness Training and Programs, Systemic and Individual Diversity Change Initiatives, The Future of Diversity – A Global Perspective.	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the nuances of workforce diversity
4	**Technology in Human Resource** Administration and Human Resource Information Systems, Talent Management, Job Analysis and Human Resource Planning, Recruitment and Selection in an Internet Context, Training and Development: Issues and Human Resource Information Systems Applications, Performance Management, Compensation, Benefits, Payroll and the Human Resource Information Systems, International Human Resource Management	Case Study/ Role-play/ Drama/ Group Discussion	Overview of application of technology in HR
5	**Introduction to Analytics** : Introduction to Business Analytics : Need for Analytics : Use of Analytics in business : Introduction to HR Analytics : HR Analytics and people strategy : Becoming a persuasive HR function	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to HR Analytics
7	Case Studies and Presentation.		

Text books

1	Human Resource Planning – James W Walker
2	Human Resource Development – Uday Kumar Haldar – Oxford Publications
3	Managing Diversity: Toward a Globally Inclusive Workplace Book by Michalle E. Mor Barak.
4	HR Analytics: The What, Why and How : Tracey Smith

Reference books

1	Human Resource Planning – D.K Bhattacharya
2	Human Resource Planning – M.S Reddy
3	Planning & Managing Human Resources – William J Rothwell, H.C Kazanas

Assessment

Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - III

HRM (ELECTIVES)

Semester	**:**	**III-Electives**			
Title of the Subject / course	**:**	**Personal Growth Laboratory**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Basics of personality, personality types
2	Introduction to emotional intelligence
3	Stress and stress control techniques
4	Introduction to NLP and transactional analysis
5	Techniques of effective team building

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Personal Growth (Personal Effectiveness)** Introduction to personal growth : Meaning, Nature and Scope : Individual, Organizational and social roles : Role Clarity & Role Boundaries : Self-awareness and self-esteem	Case Study/ Role-play/ Drama/ Group Discussion	Basics of personality, Meaning of personal growth, meaning of self-awareness and self esteem
2	**Personality (Personal Effectiveness)** Personality Theories : *Carl Jung's personality types : MBTI*	Case Study/ Role-play/ Drama/ Group Discussion	Implementation of personality theories to find the personality type
3	**Personality (Personal Effectiveness)** Personality Theories : *Trait Theories : Big 5 : Type A & Type B : PF16*	Case Study/ Role-play/ Drama/ Group Discussion	Implementation of personality theories to find the personality type
4	**Basic Functions of Mind (Personal Effectiveness)** Creativity and Innovation : Blocks to Creativity : Creativity tools and processes :	Case Study/ Role-play/ Drama/ Group Discussion	Methods of improving creativity, Basics of different type of thinking techniques

Sr. No.	Content	Activity	Learning outcomes
	convergent and divergent thinking : *Six Thinking Hats*		
5	**Neuro-linguistic Programming (Personal Effectiveness)** Introduction to NLP : *NLP*	Case Study/ Role-play/ Drama/ Group Discussion	Basics of NLP and NLP implementation
6	**Emotional Intelligence (Personal Effectiveness)** Introduction to emotional intelligence : Introduction to Enneagram : *Testing Emotional Intelligence : Personality Types According to Enneagram*	Case Study/ Role-play/ Drama/ Group Discussion	Definition of emotional intelligence, Enneagram and its implementation
7	**Stress (Personal Effectiveness)** Stress and reasons behind stress : Techniques for stress busting : *Practice of some stress busting techniques*	Case Study/ Role-play/ Drama/ Group Discussion	Causes of stress and stress busting techniques
8	**Interpersonal Relations (Interpersonal Effectiveness)** Basics of Interpersonal relations : Basics of Group Dynamics : Needs of openness, inclusion and control : *Discovering interpersonal orientation through FIRO-B*	Case Study/ Role-play/ Drama/ Group Discussion	Basics of Interpersonal Relations, implementation through Firo-B
9	**Transactional Analysis and Johari Window (Personal Effectiveness)** Basics of Ego-states : Types of Transactions : Theory of Johari Window : *Implementation of Johari Window*	Case Study/ Role-play/ Drama/ Group Discussion	Basics and implementation of Transactional Analysis and Johari Window
10	**Teams and Team Building (Interpersonal Effectiveness)** Basics of Team and Team Building : Conflict in teams : Conflict Resolution : Negotiation : *Desert Survival Exercise for team building*	Case Study/ Role-play/ Drama/ Group Discussion	Team building exercises
11	**Teams and Team Building (Interpersonal Effectiveness)** *More team building activities: Simulation Games*	Case Study/ Role-play/ Drama/ Group Discussion	Team building exercises
12	**Learning Methodologies** Basics of T-group and	Case Study/ Role-play/ Drama/ Group	Leaning about different learning methodologies

Sr. No.	Content	Activity	Learning outcomes
	sensitivity training : *Application of T-group and sensitivity training*	Discussion	
13	**Learning Methodologies** Basics of Assessment Centres : *Application of Assessment Centres*	Case Study/ Role-play/ Drama/ Group Discussion	Leaning about different learning methodologies

Text books

1	Organizational Behavior : Stephen P. Robbins, Timothy A. Judge, Neharika Vohra

Reference books

1	Six Thinking Hats by Edward De Bono
2	Introducing NLP: Psychological Skills by Joseph O'Connor
3	Essential Enneagram: The Definitive Personality Test and Self-Discovery Guide -- Revised & Updated by David Daniels and Virginia Price
4	Assessment Centres: Identifying Potential and Developing Competency by Nitin Sawardekar

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Electives**			
Title of the Subject / course	**:**	**Global HRM**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

	To understand the concept of Human Resource Management in an international context, understand the challenges of operating in different geographies and relevant differences in culture

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning Outcome
1	**Introduction and Overview of Domestic HRM and IHRM** a. The professionalism of HRM b. International trends in the labour force c. The impact of the environment, competition and the dynamics of the labour force on HRM	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to the concept of International HRM and the differences between domestic and international HRM
2	**Selecting and Managing International Workforce** a. The influences of cross cultural issues on organisations b. Selection, evaluation and coaching of international employees c. Developing Planning, Communications and Intercultural skills to manage a cross cultural workforce d. Global training and appraisal systems for a cross cultural workforce e. Compensation and performance measure: an international perspective	Case Study/ Role-play/ Drama/ Group Discussion	Learning planning and recruitment techniques in the international context
3	**International Organisations and Industrial Relations** a. Corporate Culture and change b. Policies and practices of multinational companies c. Employment and Labour Laws: an international perspective	Case Study/ Role-play/ Drama/ Group Discussion	Study of Employment Relations in an international context

Sr. No.	Content	Activity	Learning Outcome
	d. The influence of Trade Unions e. Equal Opportunities f. Employment relations		
4	**International Compensation and Benefits** a. Theory of Employee Development b. Objectives of International Compensation c. Benchmarking global practices d. Motivation and Reward systems e. Problems with global compensation	Case Study/ Role-play/ Drama/ Group Discussion	Study of International Compensation and Benefits, global practices and challenges
5	**Expatriation and Repatriation** a. Characteristics of effective expatriate managers b. The role of family c. Dealing with culture shock d. Successful repatriation practices	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the concept of Expatriation and Repatriation
6	**Legislation and the international workforce** a. Legislation and the international workforce b. Employment Law c. Trade Unions and negotiations	Case Study/ Role-play/ Drama/ Group Discussion	Understanding employment law in international context
7	**International Training and Development** Define and contrast between training and development Developmental aspect of international assignments and its relation to international career paths Training and developing international management teams Trends in international training and development	Case Study/ Role-play/ Drama/ Group Discussion	Understand components of International Learning and Development in organizations
8	Global Unions, Regional Integration and Framework Agreements	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Global Unions, Regional Integration and Framework Agreements and its impact on the organizations
9	Emerging Trends in Employee Relations and Employee Involvement	Case Study/ Role-play/ Drama/ Group Discussion	Study of Emerging Trends in Employee Relations and Employee Involvement in international context
10	International Labour Standards	Case Study/ Role-play/ Drama/ Group Discussion	International Labour Standards
11	Case Studies and Presentations	Case Study/	

Sr. No.	Content	Activity	Learning Outcome
		Role-play/ Drama/ Group Discussion	

Text books

1	International Human Resource Management by K Aswathappa and Sadhna Dash , TMGH

Reference books

1	International Human Resource Management by Peter j Dowling, Device E Welch, 4th Edition.
2	International Human Resource Management by Hilary Harris, Chris Brewster and Paul Sparrow, VMP Publishers and Distributors

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Electives**			
Title of the Subject / course	**:**	**Employee Branding and Employer Value Proposition**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Concept of Employee Brand
2	Concept of Employer Value Proposition
3	Creating and Nurturing Employee Brand

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Birth of Employee Brand Concept** Changing needs and aspirations of employees : Challenge of managing people : Leadership and its role : Birth of Employee Brand Concept	Case Study/ Role-play/ Drama/ Group Discussion	Learning factors leading to birth of employee brand
2	**Fundamentals of Branding** Definition : Brand Personality : Brand Positioning and Differentiation : Brand Vision : Brand Hierarchy : Brand Reality : Brand Management and Development : Brand Consistency and Continuity	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the concept of a brand
3	**Benefits of Employee Branding** Functional Benefits : Emotional Benefits : Higher Order Benefits : Life Cycle Benefits	Case Study/ Role-play/ Drama/ Group Discussion	Learning the benefits of employee branding
4	**Employee Brand Insight** Employee Insights : Labor Market Insights	Case Study/ Role-play/ Drama/ Group Discussion	Employee Brand Insights
5	**Before Employee Brand Creation** Diagnosing Employee Brand : Preparing to create the Employee Brand	Case Study/ Role-play/ Drama/ Group Discussion	Preparing to create an employee brand
6	**Employee Brand Creation** Creation of Employee Brand : Operationalization of Employee Brand	Case Study/ Role-play/ Drama/ Group Discussion	Creation and Operationalization of Employee Brand

Sr. No.	Content	Activity	Learning outcomes
7	**Employee Brand Creation** Brand Identity : Brand Integration : Corporate Brand Hierarchy : Key components of Positioning Model : Brand Reality Model : Brand Vision Model	Case Study/ Role-play/ Drama/ Group Discussion	Learning the different facets of brand creation
8	**Nurturing the Employee Brand** Documentation : Change Management : Measurement of Impact	Case Study/ Role-play/ Drama/ Group Discussion	Learning about the methods of Nurturing the Employee Brand
9	**Employer Value Proposition** Definition of Employer Value Proposition : Link to theories of motivation	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the concept of Employer Value Proposition
10	**Employee Brand Communication** Identity : Launch : Rational Understanding : Emotional Engagement : Employee Commitment and behavior change	Case Study/ Role-play/ Drama/ Group Discussion	Learning various Employee Brand Communication techniques
11	**Employer Brand Management : Big Picture** Policy : External Reputation : Internal Communication : Senior Leadership : Values and CSR : Internal Measurement System	Case Study/ Role-play/ Drama/ Group Discussion	Employer Brand Management at a larger scale
12	**Employer Brand Management : Local Picture** Recruitment and Induction : Team Management : Performance Appraisal : Learning and Development : Reward and Recognition	Case Study/ Role-play/ Drama/ Group Discussion	Employer Brand Management at a smaller scale
13	**Durability of Concept of Employee Brand**	Case Study/ Role-play/ Drama/ Group Discussion	Durability of Concept of Employee Brand

Text books

1	The Employer Brand Bringing the Best of Brand Management to People at Work: Simon Barrow & Richard Mosley

Reference books

1	Brand From the Inside: Libby Sartain & Mark Schuman

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Electives**			
Title of the Subject / course	**:**	**HR Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Basics of HR Analytics
2	Introduction to latest technologies including SPSS, Big Data
3	Using HR Analytics for various functions of HR
4	Different Analysis Strategies
5	Ethics and Limitations while using HR Analytics

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Introduction to HR Analytics** Introduction to Analytics : Introduction to Business Analytics : Need for Analytics : Use of Analytics in business : Introduction to HR Analytics : Evolution of Analytics : HR Analytics and people strategy : Becoming a persuasive HR function	Case Study/ Role-play/ Drama/ Group Discussion	Learning the basics of Analytics and HR Analytics, Relation of HR Analytics with HR strategies
2	**Metrics and Analytics** Language of Metrics and Analytics : Descriptive Analytics : Prescriptive Analytics : Casual Analysis : Predictors, prediction and predictive modelling : Business applications of modeling	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Different categories of HR Analytics, Applications of modeling
3	**HR Information Systems and Data** Information Sources : Analysis software options : Preparing data : Using SPSS : Big Data	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to analysis using SPSS and big data
4	**Analysis Strategies** From descriptive reports to predictive analytics : Statistical Significance : Types of data : Types of statistical tests : Factor Analysis and reliability analysis	Case Study/ Role-play/ Drama/ Group Discussion	Different types of statistical analysis techniques
5	**Recruitment and Selection Analytics** Reliability and validity of selection process : Human bias in recruitment and selection	Case Study/ Role-play/ Drama/ Group Discussion	Application of analytics in recruitment
6	**Predicting Employee Performance** Indicators of performance : Methods for	Case Study/ Role-play/	Application of analytics in employee performance

Sr. No.	Content	Activity	Learning outcomes
	measuring performance	Drama/ Group Discussion	
7	**Employee Engagement and Workforce Perceptions** Measuring Employee Engagement : Interrogating the measures : Conceptual Explanation of factor analysis	Case Study/ Role-play/ Drama/ Group Discussion	Application of analytics in employee engagement
8	**Predicting Employee Turnover** Importance of employee turnover as an HR information : Descriptive Turnover Analysis : Measuring and exploring differences between turnover at an individual or team level	Case Study/ Role-play/ Drama/ Group Discussion	Application of analytics in assessing employee turnover
9	**Monitoring the Impact of Interventions** Tracking the impact of various HR interventions : Value change initiative	Case Study/ Role-play/ Drama/ Group Discussion	Application of analytics in tracking the impact of HR interventions
10	**Diversity Analytics** Equality, diversity and inclusion : Approaches to measuring and managing D&I	Case Study/ Role-play/ Drama/ Group Discussion	Application of analytics in assessing diversity
11	**Advanced HR Analytic Techniques I** Mediation Processes : Moderation and interaction analysis : Multi-level linear modelling : Curvilinear relationships	Case Study/ Role-play/ Drama/ Group Discussion	Learning Advanced HR Analytics Techniques
12	**Advanced HR Analytic Techniques II** Structural Equation Models : Growth Models : Latent class analysis : Response surface methodology and polynomial regression	Case Study/ Role-play/ Drama/ Group Discussion	Learning Advanced HR Analytics Techniques
13	**Usage, Ethics and Limitations** Institutionalized Metric Oriented Behaviour (IMOB) : Importance of quality data and measures : Ethics in Analytics : Ethical Standards for HR Analytics team : Limitations	Case Study/ Role-play/ Drama/ Group Discussion	Understanding Ethics involved and limitations of HR Analytics

Text books

1	The New HR Analytics : Predicting the economic value of your company's human capital investment : Jac Fitz-enz
2	HR Analytics: The What, Why and How : Tracey Smith

Reference books

1	Predictive HR Analytics: Mastering the HR Metric : Dr Martin R. Edwards, Kirsten Edwards

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III-Electives**			
Title of the Subject / course	:	**O.S.T.D.**			
Course Code	:				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	To understand the organizational design and different factors affecting organizational design
2	To study the evolution of organizational theories
3	To appreciate the organizational culture and its effect on organizational design

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning Outcome
1	**Organizations and Organization Theory** a. Organization theory in action. b. What is an organization? c. Perspectives on organizations: open systems and organizational configuration. d. Dimensions of organization design: structural and conceptual. e. The evolution of organization theory and design	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to the concept of an organization and organization design. Study of evolution of organization theory
2	**Strategy, Organization Design, and Effectiveness** a. The role of strategic direction on organization design. b. Organization purpose. c. A framework for selecting strategy and design/structure. d. Assessing organizational effectiveness. e. Contingency effectiveness approach, resource based approach, and internal process approach. f. An integrated effectiveness model	Case Study/ Role-play/ Drama/ Group Discussion	Study of effect of strategy on organization design Learning about organizational effectiveness and its assessment
3	**Fundamental of Organization Structure** a. Organization structure b. Information processing perspective in organization structure c. Organization design alternatives	Case Study/ Role-play/ Drama/ Group Discussion	Study of basics of organization structure

Sr. No.	Content	Activity	Learning Outcome
	d. Functional, divisional, and geographical designs e. Matrix structure f. Horizontal structure g. Modular structure h. Hybrid structure		
4	**Open Systems Design Elements** a. The external environment. b. Inter-organizational Relationships. c. Organization size and life cycle and design/structure. d. Comparative management.	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the external environment, organizational life cycle and Inter-organizational Relationships
5	**Organizational Culture** a. Organizational culture. b. Organization design and culture. c. Culture and the learning organization. d. Ethical values in organizations. e. Leadership and culture and ethics.	Case Study/ Role-play/ Drama/ Group Discussion	Study of organizational culture and its effect on organization design
6	**Innovation and Change and Organizational Design** a. The strategic role of change. b. Elements of successful change. c. New products and services. d. Technology change. e. Strategy and structure change. f. Culture change. g. Strategies for implementing change.	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to change and its effect on organizational design
7	**Decision-Making Process** a. Rational approach. b. Bounded rationality perspective. c. Organizational decision-making. d. The learning organization. e. Contingency decision-making perspective. f. Special decision circumstances.	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to decision making process
8	**Conflict, Power, and Politics** a. Intergroup conflict in organizations. b. Power and organizations. c. Political processes in organizations. d. Using power, politics, and collaboration.	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the concepts of conflict, power and politics in an organization
9	Case Studies and Presentations	Case Study/ Role-play/ Drama/ Group Discussion	

Text books

1	Robins Khandwalla, P. N. Organizational design for excellence, New Delhi, Tata McGraw Hill, 1992

Reference books

1	Daft, R. L. Organization Theory and Design, Current Edition. Thomson Southwestern

Assessment

Internal	40%
Semester end	60%

Semester	:	**III - Elective**			
Title of the Subject / course	:	**HR Audit**			
Course Code	:				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

	Understanding HR Accounting and Audit with study of various instruments such as HR Score Card. Learning to calculate HR cost, investments and return on investments and preparing HR Audit Reports

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning Outcome
1	Introduction a. HR as assets b. Definition of Human resource accounting c. HRA – concepts, methods and applications d. Human Resource accounting vs. Other Accounting	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to Human Resource Accounting
2	Human Resource Costs / Investments a. Human Resource Costs – the Monetary Value Approach, Non-Monetary value Based Approaches b. Investment in employees -- Human resource Development	Case Study/ Role-play/ Drama/ Group Discussion	Learning to calculate human resource cost/investments
3	Return on Investments a. Development of HR ROI into through High Performance Employees b. Measurement of Group Value – The Likert and Bowers Model, Hermanson's unpurchased goodwill model	Case Study/ Role-play/ Drama/ Group Discussion	Learning to calculate human resource return on investments
4	Human Resource Accounting System a. Developing Human Resource Accounting System b. Implementation of Human	Case Study/ Role-play/ Drama/ Group Discussion	Learning development and implementation of HR accounting system

Sr. No.	Content	Activity	Learning Outcome
	resource Accounting system c. Integration with other accounting system		
5	Human Resource Score Card a. HR Score Card, constituents of HR Scorecard b. HR score card as an instrument in HR Audit	Case Study/ Role-play/ Drama/ Group Discussion	Introduction of HR Score Card and its implementation
6	Human Resource Audit a. Role of Human resource audit in business environment b. HR Audit Objectives, Concepts, Components, Need, Benefits, Importance c. Methodology and instruments of HR Audit d. The audit process and Issues in HR Audit	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to HR audit
7	Human Resource Audit Report a. HR Audit Report – purpose b. Report Design – Preparation of report c. Use of HR Audit report for business improvement	Case Study/ Role-play/ Drama/ Group Discussion	Learning to prepare HR Audit Report
8	Recent Advancements in Human Resource Audit and Accounting	Case Study/ Role-play/ Drama/ Group Discussion	Exploring recent advancements in Human Resource Audit and Accounting
9	Case Studies and Presentations	Case Study/ Role-play/ Drama/ Group Discussion	

Text books

1	Personnel & Human Resource Management – P. Subba Rao.

Reference books

1	Human Resource and Audit – T.V.Rao
2	Human Resource System – T.V.Rao & Udai Pareek

Assessment

Internal	40%
Semester end	60%

Semester	:	**III - Elective**			
Title of the Subject / course	:	**Employee Relations and Labour Laws and Alternate Dispute Resolution**			
Course Code	:				
Credits	**:**	**4**	**Duration in Hrs**	**:**	**40**

Learning Objectives

1	Understanding Nature and Importance of IR
2	To understand Conflict preventing & resolution methods under IR
3	Discussing practical cases in IR
4	New trends in IR and future of IR

Module

Sr. No.	Content	Activity	Learning outcomes
1	**History & Growth of IR in India** • Pre independence • Post independence. • Post Liberalization. • India & ILO		Discuss the history of the IR movement and growth in India
2	**IR issues in Organizations** • IR Definitions • Different approaches to IR: a) Functional approach b) Systems approach & Dunlop's Contribution c) Oxford Model d) HR approach e) Comprehensive IR model of internalist & externalist approach		Discuss various definitions of IR & IR approaches with their advantages and disadvantages
3	**Prevention Machinery of Conflict in IR** • Issues & Levels of conflict in IR, The State & Industrial Relations Policy, Tripartite & Bipartite Bodies, Ethical Codes & IR, • Industrial Employment (Standing Orders) Act,1946, Model Grievance Procedure & Disciplinary Proceedings • Overview of Trade Union Movement, Union Politics, Difference between Trade union registration & recognition. Trade Union Registration Act 1926. Union	Case Studies	Understanding the genesis of conflict in IR and various methods prevent the same.

	recognition under MRTUP&PULP & Code of Discipline • Conditions for effective Collective Bargaining and process of CB.		
4	**<u>Conflict Settlement Machinery in IR - II</u>** • Industrial Dispute Act – 1947 • Alternate Dispute Resolution (ADR) a) What is It? b) Discuss cases using ADR to settle cross cultural, environment, healthcare business disputes c) ADR Clause Drafting	Cases Studies	Understanding various methods to solve the conflict. Drafting simple settlement agreements and discuss issues related to enforceability of agreements
5	**<u>Labor Welfare</u>** • Labor Welfare- a) Concept of Labor Welfare b)Approaches to Labor Welfare c) Statutory and Non-Statutory Welfare • Workers Participation in Management- a) Experiences of Germany, France & Britain. b)Indian experience, Suggestion schemes, Kaizen, Quality circles, TQM,ISO, Productivity Bargaining	Case Studies	To highlight the importance of Labor welfare & workers participation in management and how can it help for smooth industrial relations
6	**<u>New trends in IR & Future of IR in India 2020</u>** • The changing demographics of Indian Industry, manufacturing to service sector, from formal to informal, digitization etc. • Expected changes in the dynamics of IR in this changed Industry model • Ways to cope up with these problems • Collaboration a new outlook to IR	Guest Lecture	This chapter is expected to be thought completely with practical examples of companies. No particular book required for the same
7	Internal Assessments		
8	Revision		

Text and Reference books

1	Mamoria, C. B. & Mamoria, S. Dynamics of Industrial Relations in India. Himalaya Publishing House
2	Sharma, A. M. Industrial Relations: Conceptual & Legal Framework. Himalaya Publishing House
3	Mamoria, C. B., Mamoria, S. & S. V. Gankar. Dynamics of Industrial Relations in India. Himalaya Publishing House
4	Venkata Ratnam, C. S. Industrial Relations. Oxford University Press
5	Industrial Relations – Late C.S Venkata Ratnam – Oxford Publications
6	Industrial Relations, Trade Unions and Labour Legislation – P.R.N Sinha, Indu Bala Sinha, Seema Priyadarshini Shekhar – Pearson Publications
7	Alternative Methods of Dispute Resolution By Martin A. Frey
8	ADR principles and practice By Henry J. Brown
9	Getting to Yes: Negotiating Agreement Without Giving In By Roger Fisher and William Ury
10	Dispute resolution : negotiation, mediation, arbitration, and other processes By Stephen B. Goldberg,
11	Sharma, A. M. Industrial Relations: Aspects of Labour Welfare & and Social Security. Himalaya Publishing House
12	Sharma, A. M. Industrial Relations: Industrial Jurisprudence and Labour Legislation. Himalaya Publishing House

Assessment

Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - III

OPERATIONS (CORE)

Semester	**:**	**III Core**			
Title of the Subject / course	**:**	**Supply Chain Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Familiarize with the basic concepts of Logistics Management in relation to Inbound Logistics, Process Logistics, and Outbound Logistics phases of business.
2	To explore the major elements of supply chain and expose to leading edge thinking on supply chain strategy, Designing supply chain, customer satisfaction; inventory management; risk management, alliances, issues and challenges, performance measurement.
Prerequisites if any	
Connections with Subjects in the current or Future courses	International Logistics

Module

S No	Content	Activity	Learning outcomes
1	**Understanding the supply chain** What is a supply chain? Decision phases in a supply chain. Evolution of SCM, SCM integration, Linkages and Decisions in SCM. Difference of Supply Chains in Product (Mfg.) Industry and Service-based Industry. Supply Chain and Demand chain, Value creation. Delivery and Value addition through supply chain. Process view of a supply chain. The importance of supply chain flows. Competitive Supply Chain Strategies. Achieving strategic fit.	Lecture and discussion.	Understanding of Supply chain
2	**Logistics** Competitive advantage and three C, Competitive advantage through logistics. Logistics-A system concept, Customer value chain, Logistics functions. Logistics Mission, Objectives, Goals, Decisions. Reverse Logistics.	Lecture and discussion.	Understanding of Logistics concept
3	**Warehousing and Distribution** Role of warehouse in Logistics,	Lecture and discussion.	Understanding of Warehousing function

S No	Content	Activity	Learning outcomes
	Warehousing functions, Types of warehouses Warehouse site selection, Layout design, Warehouse Decision model. Warehouse automation, strategies, performance, costing. Distribution, Role, Importance, Levels, Channels, Structure, Functions. Channel partners, functions, Tasks, Flows, Strategy. Free trade zones and special economic zones.		and distribution channel
4	**Order Processing and Logistics Information system** Order Preparation, Transmittal, Order entry, Order filling, Order status reporting Industrial order processing and Retail order processing. Web based order processing. Processing priorities.	Lecture and discussion.	Understanding of Warehouse process and logistics information system
5	**Performance Measurement and Controls in Supply Chain Management** Pre- transaction, Transaction, Post-transaction elements, Service attributes Value added customer service, Importance of Logistics Customer service Sales and Service relationship, Cost and Service relationship. Objective, Levels, Parameters of performance measures- Cycle time, Fill Rate. Inventory Turnover, On-time Shipping and Delivery, Perfect Order, Stock out. Transportation measurements, Customer perception measure, Audit. Gap Analysis Concept of Benchmarking Benchmarking for Best Practices SCOR and DCOR	Lecture and discussion.	Understanding of customer service and performance measurement
6	**Transportation** Infrastructure, road, rail, air water, pipeline. Freight Management, Freight cost. Transportation Network Route planning, Containerization, Packing. Effective / Cost Optimizing Distribution strategies- Direct shipment, Cross-docking, Milk run, transshipment.	Lecture and discussion.	Understanding of Transportation modes

S No	Content	Activity	Learning outcomes
7	**Designing Logistics and distribution network in a supply chain** **Applications to Online Sales** **Network Design in the SC** **t**he role of distribution in the supply chain. Importance of Smart Transportation Distribution Center Concept , Modern DC's , Robotics Usage for pick and pack Factors influencing distribution network design. **Supply Chain Integration** Design option for a distribution network. Distribution network in practice.	Lecture and discussion.	Understanding various distribution networks
8	**The value of Information** Bullwhip effect. Effective forecasts. Information for the coordination of systems. Collaborative Planning Forecasting Replenishment (CPRF) concept. Locating desired products. Lead time reduction. Information and supply chain trade-off. Designing the supply chain for conflicting goals. **Inventory Management and Risk pooling, Logistics Information system** Function, OMS, WMS, TMS. Internal Operations – Input, Database management, Output	Lecture and discussion.	Understanding importance of information in supply chain.
9	**Strategic Alliances** A framework for strategic alliances. Third party / fourth party logistics. What are 3PL/4PL, Advantages and disadvantages of 3PL, 3PL issues and requirements? Retailer supplier partnership. Types of RSP, Requirements of RSP Inventory ownership in RSP, Issues and steps in RSP implementation Advantages and disadvantages of RSP. Distribution Integration Types of and issues in Distribution integration. **Customer Value**	Lecture and discussion.	Understanding of various outsourcing activities and RSP
10	**E-procurement and outsourcing** Outsourcing benefits and risks. A framework for Buy/Make decisions E-procurement. A framework of E-	Lecture and discussion.	Understanding procurement through Internet and impact.

S No	Content	Activity	Learning outcomes
	procurement. Impact of Internet on supply chain strategies (E-business).		
11	**Designing Global Supply Chain Networks** Global market / Technological/ Cost/ Political and Economic Forces. Risks and advantages of international supply chain. International versus Regional products. Local autonomy versus central control. Regional differences in Logistics- Cultural differences/ infrastructure/ performance expectation and evaluation Information systems availability, human resources. Global business logistics.	Lecture and discussion.	Understanding various international issues and challenges
12	**Performance Measurement and Controls in Supply Chain Management** Measurement of a Robust Supply Chain. Cost / Quality / Service Measurement Introduction and concept of Benchmarking. Gap Analysis. Key actions in benchmarking for best practices. Overview of Supply Chain Operations Reference (SCOR) Modeling. Balance scorecard for SCM. **Lean Manufacturing and Mass Customisation**	Lecture and discussion.	Understanding various performance measurements tools in supply chain.
13	**Ethical issues in SCM** Supply chain vulnerability. Conformance to applicable laws such as Contract and commercial laws, Trade regulation, government procurement regulations, patents Copyrights, trademark laws, transportation and logistics laws and regulations Environmental laws. International practices. Confidentiality and proprietary information.	Lecture and discussion.	Understanding various ethics, Rules and regulations in supply chain.
14	**Current Trends in Supply Chain** Goldratt Supply Chains Sustainable Supply Chain Resilient supply chains Green Supply chain Lean supply chain	Lecture and discussion.	Understanding recent trends in supply chain.

Text books		
1	Supply Chain Management - Strategy, Planning and Operation	Sunil Chopra and Peter Meindl
2	Supply Chain Management by	Simchi Levi

Reference books		
1	Logistics Management	V.V.Sople
2	Supply Chian Management	V.V.Sople
3	Business Logistics	Ronald H.Ballou
4	Logistics and Supply Chain Management	Martin Christopher
6	Designing & Managing the supply chain	David, Philip Kminsky

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Core**			
Title of the Subject / course	**:**	**Operations Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand basic aspects of analytics and evaluation
2	To learn various analytical techniques applied in complex real life situations
3	To be able to scale up an academic model to workable practical model by carrying the process of analytical framework.

Prerequisites if any	Operations Management, Operations Research, Statistics for Management,
Connections with Subjects in the current or Future courses	Supply Chain Management, MRPC, Materials Management.

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Gaining data insights and Predictive Analytics Introduction to analytics, Demand analytics-qualitative forecasting	Lecture, examples on excel, cases	Understand Forecasting and predictions
2	Demand analytics –quantitative forecasting ,Moving average, exponential smoothing, trend, regression adjusted with seasonality, double exponential smoothing, optimum values of period of MA & smoothing constant	Lecture, examples on spread sheets, cases	Understand and use various techniques for demand forecasting
3	Measures of accuracy in forecasting in terms of MAD,MSE,MAPE & tracking signal	Lecture, examples on spread sheets, cases	To evaluate the appropriateness of the projective technique
4	Service analytics in waiting line, single & multiserver, use of simulation and customer service efficiency, cost optimization	Lecture, examples on spread sheets, cases	To understand service efficiency analysis
5	Service analytics in Retail, stocking policy and impact of stock-out, use of simulation, service efficiency,& cost optimization	Lecture, examples on spread sheets, cases	To know management of service operations in Retail
6	Supply Chain Analytics: Supply Chain Metrics, Decision areas in SCM Procurement, Manufacturing, Distribution, Logistic s, Global	Lecture, examples on spread sheets, cases	To identify the supply chain related measurement
7	Supply chain analytics, Risk & performance indices wrt cost, capacity,	Lecture, examples on	To understand and list the risk and

Sr. No.	Content	Activity	Learning outcomes
	quality, logistics & distribution etc	spread sheets, cases	performance of supply chain
8	Types of Reports: Summary Reporting, Detailed, Functional, Multi-view, Drill Down, Utility View, Process View	Lecture, examples on spread sheets, cases	To know the reporting of the analytics
9	Performance Metrics: Inventory, Fulfillment, Alerts, and Flagging etc. Dash Board Designing, Balanced Scorecard: Kaplan and Norton Framework, Strategy Map, Scorecard Design	Lecture, examples on spread sheets, cases	To understand performance metrics in various cases

Text books		
1	Business Analytics: Practitioner's Guide	Rahul Saxena and Anand Srinivasan
2		

Reference books		
1	Business Analytics- An Introduction	Jay Leibowitz
2		

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Core**			
Title of the Subject / course	**:**	**Service Operations Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Understanding various types of Service Industry
2	Site selection for service location
3	Role of Operations for Profitability in Service industry
4	Inventory management in Service industry
5	Basics of Outsourcing/Offshoring in Services

Prerequisites if any	Operations Management Operations Research Statistics for Business
Connections with Subjects in the current or Future courses	Materials Management, Supply Chain Management

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Services:** a) Introduction b) Characteristics of Services, c) Importance of Service Sector,	Lecture with discussion	Better understanding of services
2	Classification of services a) Classification framework, b) Service Delivery System – Process Flow Diagrams, blue printing c) Process Simulation	Lecture with discussion	Understanding of workflow of Services
3	Site Selection for Services: a) Types of Service Firms – b) Demand Sensitive Services, c) Delivered Services, d) Quasi-manufacturing Services,	Lecture with discussion & examples	Understanding complexity of services
4	Site Selection for Services: a) Site Selection for Demand Sensitive Services – Factor Rating, – Regression, –GIS, –Gravity Model of Demand	Developing quantitative models for various situations	Developing quantitative ability for decision making
5	Site Selection for Services: a) Site Selection for Delivered Services – Expected Results, – Mathematical Solution Methods for delivered services,	Developing quantitative models for various situations	Developing quantitative ability for decision making

Sr. No.	Content	Activity	Learning outcomes
6	Site Selection for Services: a) Site Selection for Quasi-Manufacturing Services – Mixed Linear / Integer Programming for Location Selection	Developing quantitative models for various situations	Developing quantitative ability
7	Yield Management: a) Capacity Strategies for Yield Management, b) Overbooking,	Developing quantitative models for various service situations	Understanding Profitability in Service Industry
8	Yield Management: c) Allocating Capacity – Static Methods, –Nested Static Methods, –Dynamic Methods. d) Pricing, e) Implementation issues – Alienating Customers, –Customer Class Cheating, –Employee Empowerment, f) Cost and Implementation Time.	Developing quantitative models for various service situations	Understanding Profitability in Service Industry
9	Inventory Management in Services: a) Services versus Manufacturing Inventory, b) Set Up and Ordering Costs, c) Number of Products, d) Limited Shelf Space, e) Lost Sales versus Back Orders, f) Product Substitution, g) Demand Variance, h) Information Accuracy	Lecture with discussion	Understanding Inventory in Service Industry
10	Inventory Management in Services: a) The Newsvendor Model, b) Multiple Products and Shelf Space Limitations,	Quantitative Models	Inventory control in Service industry
11	Inventory Management in Services: a) Inventory Inaccuracy b) Phantom Stock outs, c) Shrinkage. d) Revenue Sharing, e) Markdown Money,	Lecture with discussion	Inventory control in Service industry
12	Outsourcing: a) Contract risk, b) Outsource Firm Risk	Lecture with discussion	Outsourcing concept in services

Sr. No.	Content	Activity	Learning outcomes
	c) Pricing Risk, d) Competitive Advantage e) Information Privacy Risk, f) Firm Specific Risks		
13	Offshoring : a) Quantifying Offshoring, b) Offshoring and Competitive Capabilities c) Cost Issues d) Non-cost Issues.	Lecture with discussion	Outsourcing concept in services
14	Performance measurement of Service Operations: a)Productivity Measures b)Cost Measures c) SERVQUAL model	Development of measures in the class for various industries	Assessment of Performance of Services

Text books		
1	Successful Service Operations Management	Metters, King-Metters, Pulliman and Walton
2	Operations Management (Theory & Practice	B Mahadevan
Reference books		
1	Service Operations Management - Improving Service delivery	Robert Johnston Graham Clark,
2	Service Operations Management	Fritzsimmons
Assessment		
Internal	40% or 25 %	
Semester end	60% or 75 %	

Semester	**:**	**III Core**			
Title of the Subject / course	**:**	**Manufacturing Resource Planning and control**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand importance of manufacturing resources planning and control to achieve continuous improvement in the better performance.
2	To give knowledge of quantitative methods as well as various tools of resources planning like MRP1,MRP2 & ERP for decision making in operations.

Prerequisites if any	Operations management
Connections with Subjects in the current or Future courses	Materials Management , SCM

Module

	Content	**Activity**	**Learning outcomes**
1	Overview of operations planning & control recent business environment, Challenges in competitive edge.	Lectures	
2	Various Manufacturing resources importance their planning and control. Functions of operation planning and control	Lectures	
3	Hierarchy of production plans overview, linkages to achieve business plans	Lecture	
4	Various models optimization line balancing models. Demand management capacity planning models lay out models.	Lectures, application in the practice	
5	Mater production scheduling module (I) Need objectives functions flow of materials in different manufacturing scenarios	Lectures, case studies, application	
6	MPS module (II) Broader heading, planning horizon time periods, order management, safety and hedges, effect of changing MPS.		
7	Materials requirement planning MRP1 Broader topics: Introduction roles & functions. Independent & dependent demand, Types of Bills of materials, Quantitative problems, MRP as systems.	Lectures application and numerical problems	
8	Capacity Management: Introduction to capacity, capacity management, need capacity planning level visa visca, production planning. 1) Capacity expansion strategies 2) Rough out capacity planning RCCP	Lecture application Numbering Problems.	

	Content	Activity	Learning outcomes
	3) CRP- Capacity requirement Planning 4) Scheduling strategies 5) Production smoothly policies 6) Finite & Infinite loads.		
9	Manufacturing Resource planning MRP II (Module I) : Introduction to MRP II, Roles functions frame work of information flow in MRP II, Relation of MRP II with demand management and capacity management manufacturing calendar.	Lecture and application	
10	MRP II module II: Transition of MRPI to MRPII closed loop MRP, comparison between MRP1 & MRP II benefits.	Lecture and case studies	
11	ERP – Need, function & utility to business ERP-SAP-PPC modules. Reports, Interpretation variance. Analysis – use in decision making.	Lecture and case studies	
12	Case studies & presentation on all above topics.		

Text Books		
1	Production/ Operations Management	Ashwathappa & Shridhar Bhat
2	Operations Management (Theory & Practice)	B. Mahadevan Person publication 2nd edition.
3	Production/ Operations Planning and Control	Stephen Chapman
Reference books		
1	Elements of production planning & control	Samuel Eilon
2	Operations Planning & Control	S.K Mukhopadhaya
3	Manufacturing Planning and Control	Volmann, Berry, Whybark

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Core**			
Title of the Subject / course	**:**	**Materials Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Importance of Materials Management w.r.t. Business
2	Learning various aspects of Purchase & warehousing
3	Understanding documents control w.r.t. Material movement
4	Materials planning with quantitative models
5	Financial aspects of Materials Management
6	Importance of Ethics in Materials Management

Prerequisites if any	Operations Management, Operations Research
Connections with Subjects in the current or Future courses	Supply Chain Management, MRPC

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Materials Management an overview a) Introduction, b) Importance of Materials Management c) Objectives of Materials Management d) Costs involved in the Management of Materials e) Integrated approach to Materials Management f) Organizing Materials Management. g) Organization based on Commodities/Location/function h) Centralized versus Decentralized materials management.	Lecture	Preparation for the course in respect Operations as well as Organization
2	Materials Planning a) Introduction and factors influencing materials planning b) Techniques of materials planning c) Bill-of-Materials d) Materials Requirement Planning (MRP). e) Past Consumption Analysis Technique	Lecture/ Discussion/ Problems from Industry using computers	Planning with financial perspective Understanding impact of MRP on financial statements
3	Purchasing a) Purchasing principles, policies, procedures and practices b) Objectives, scope, responsibility and limitations c) Sources of supply and Supplier selection.	Lecture/ Industrial examples/ Problems	Overview of Purchasing activities

Sr. No.	Content	Activity	Learning outcomes
	d) Vendor development-evaluation and rating. e) Price forecasting f) Price-cost analysis g) Negotiations h) Reciprocity i) Legal aspects of purchasing j) Purchase orders/ contracts k) Method of buying- under certainty, under risk, and under uncertainty		
4	Purchasing and Procurement Activities under Materials Management. a) Supplier Quality Assurance Programme b) Buyer Supplier Relationship c) Self certified suppliers. d) Elements of procurement cycle.	Lecture/ Examples of supplier audits/ Example of procurement cycle	Detailed understanding of Purchase Process
5	Purchasing of Capital Equipment a) Significant differences b) Considerations in evaluation of bids c) Purchase of used equipment d) Sources of used equipments e) Purchase versus lease. f) Role of Purchasing Committees/ Purchase Managers	Lecture with examples from Industry	Basic understanding of purchase of projects
6	International procurement-Imports. a) International commercial terms. b) Import procedures and documentation. c) Categories of importers. d) Identification of foreign sources. e) Payment terms including Letter of credit. f) Types of L/Cs. g) Custom tariff h) Custom clearance. i) Bill of Lading and other documents	Lecture with display of relevant documents	Basic introduction to imports
7	Classification of Materials a) Introduction and objectives of classification. b) Basis of classification. c) Classification on the basis of nature of materials. d) Classification on the basis of usability of materials. f) Types of inventories.	Lecture with industrial examples/ ABC analysis problem on excel sheet with at least 20 materials	To understand how industry give selective importance to specific materials
8	Materials receipt and Warehousing a) Introduction and functions of	Lecture with development	Understanding the controls over materials

Sr. No.	Content	Activity	Learning outcomes
	scientific store management. b) Types of stores and benefits of scientific storekeeping. c) Store location and layout. d) Typical layout plans e) Storing practices and identification of materials. f) Centralization and Decentralization of stores. g) Preservation of materials h) Issue control.	of relevant documents in the class by students	
9	Codification a) Introduction b) Benefits of codification. c) Stages of scientific codification. d) Systems of codification. e) Colour coding	Lecture with day to day examples from student's presentation	Understanding the impact codification on computerization & decision making
10	Standardization a) Introduction and different levels of standards (BIS,ISI) b) Various Foreign Standards in use in India. c) How is an Indian standard evolved? d) Advantages of Standardization. e) Standardization as a tool for variety reduction f) The Role of Materials Management (Purchase/Stores) in Standardization/ Variety Reduction.	Lecture & student presentation with examples	Importance of standardization
11	Obsolete, Surplus and Scrap Management a) Definition b) Need for Scrap yard c) Identification and control. d) Categorization of obsolete/ surplus. e) Control of scrap/ obsolescence. f) Responsibility for disposal. g) Procedures and documentation for disposal of scrap/ obsolete/ surplus.	Lecture with industrial examples of Issues arising out of scrap	Understanding the processes & financial impacts
12	Stores Accounting and Stock verification a) Costing of Receipt of Materials. b) Costing of Issues to Production. c) Stock verification d) Periodic Verification. e) Perpetual Verification. f) Process of Verification	Lecture with stock taking activity in the class of the class	Learning the industry process & its financial impacts

Sr. No.	Content	Activity	Learning outcomes
13	Ethics in Materials Management a) Importance of Ethics b) Business Ethics c) Ethics in buying d) Code of ethics e) Problems in Ethics f) Backdoor selling	Lecture with examples	Importance of Ethics in Materials Management
14	Material Handling a)20 Principles of Material Handling b)Palletisation c)Containerization d)Transportation Modes / Attributes e)Transportation mix in Economy f)Total cost concept in Material Handling and Transportation	Lecture	Basic introduction to Materials handling

Text books		
1	Purchasing and Materials Management	P.Gopalkrishnan (Tata McGraw Hill, New Delhi).
2	Materials Management –An integrated approach	P.Gopalkrishnan and M. Sundaresan (Prentice-Hall India, New Delhi).
3	Purchasing Management	Datta
4	Purchasing Management	Nair
Reference books		
1	Materials and Logistics Management	Prof. L.C. Jhamb (Everest Publishing House, Pune).
2	Introduction to Materials Management	JR Tony Arnold and Stephan Chapman (Pearson Education, New Delhi) 2004 Fifth Edition.
3	Purchasing and Materials Management	N.K.Nair (Vikas Publishing House, New Delhi).

Assessment	
Internal	40% or 25 %
Semester end	60% or 75 %

Programme - Masters in Management Studies

Semester - III

OPERATIONS (ELECTIVE)

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**World Class Manufacturing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To meet global markets which are more turbulent, dynamic and complex.
2	To understand the relevance of World Class Performance in competitive framework
3	To understand global markets relationship to world class performance
4	To build the framework for world class manufacturing
5	To understand the state Indian manufacturing in relation to world class standards and performance issues
Prerequisites if any	Operations Management,
Connections with Subjects in the current or Future courses	TQM.

Module

Sr. No	**Content**	**Activity**	**Learning outcomes**
1	World class manufacturing and information age. Sub Topics. Emergency of information age. Completing in information age business challenges operating environment of information age Indian global completeness and manufacturing excellent Time based competition, managing knowledge Problems in manufacturing industry co-ordination control Fragmented information infrastructure Understanding, Attribute of world class status.	Lecture Lecture & case studies Discussion in the class from students	
2	Gaining competitive advantage through world class manufacturing. Varies concepts of world class manufacturing What is world class manufacturing Various models of WCM, Various models of WCM or approaches to WCM. Practices of WCM Meaning of WCM supplier, customer	Lecture applications case studies.	

Sr. No	Content	Activity	Learning outcomes
	manufacturer quality in WCM.		
3	Systems & Tools for World Class manufacturing Overview of systems & tools Information management tools Material processing and handling tools. Product, Process design tools Flexible manufacturing systems rapid prototyping Lean Production tools. An assessment Manufacturing systems	Case studies Discussion from group Application in industries	
4	World class manufacturing- The Indian scenario. Competitiveness of Indian manufacturing. Manufacturing performance & Planned strategies of Indian manufacturing. Manufacturing readiness of Indian firms Manufacturing objectives and strategy Use of Management tools and technologies classification by breadth of Information Technology. Infrastructure and depth of manufacturing applications. Strategy for world class status, and information technology. Is India ready for world class manufacturing.	Case studies Discussion from group Application in industries	
5	Leading India towards world class manufacturing Business strategy & global competitiveness. Manufacturing strategies for information age. Developing strategic thinking as world class as STRATEGIC PERSPECTIVE. Issues in strategic planning Barriers to using information technology strategically. World Class Strategic planning and Implementation Need for performance measurement Various methods of measurement Importance of Human diversions in world class- morale and team building.	Case studies Discussion from group Application in industries	
6.	Case studies / Presentations Based on the above topics by students.	Toyota Production System Case	

Text books		
1	World class manufacturing A strategic perspective	B.S Sahay, K.B.C Saxena, Ashish Kumar.

Reference Books		
1	World class manufacturing	K . Shridhar Bhat
2	The Toyota way	Jeffrey K Liker
3	Toyota Production system	Taichi Ohno
4	Kaizen	Masaki Imami
5	Beyond TQM by	Robert L Flood.
6	Out of Crisis	Dr Deming

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Business Process Re-engineering And Benchmarking**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To understand business process reengineering
2	To know the tools and techniques for business process reengineering
3	To understand the importance of Benchmarking the business processes
4	Role of leadership, technology in Business process reengineering

Prerequisites if any	
Connections with Subjects in the current or Future courses	Strategic Operations Management

Module

Sr. No.	Content	Activity	Learning outcomes
1	Business Process Fundamentals Definition of Business Processes Business processes and functional processes Importance of focusing on business processes	Lecture and cases	Understand and know basics of Business process
2	Understanding Business Processes Customer focused analysis of business processes Identifying value adding activities	Lecture and Cases	Understand customer and value addition in Business process
3	Visualizing Business Processes Introduction to flowcharting Types of flowcharts – block diagrams, functional flowchart with time-lines Performance Measurement systems Process characteristics	Exercises for flowcharts	Know logical flows and process component
4	Types of re-engineering Process Improvement with cost reductions Achieving best-in-class with competitive focus Radical change by re-writing the rules	Lecture and cases	Know types
5	Organizing for Process Improvements Setting up teams, choosing team leaders Training teams for process improvements	Lecture, Case, and discussion	To understand implementation process
6	Benchmarking Origins of benchmarking – Xerox approach Definition of benchmarking	Case	To know benchmarking and relevance

Sr. No.	Content	Activity	Learning outcomes
7	Internal benchmarking Benchmarking against the best in the unit Benchmarking against the best in the group	Case, lecture and presentation	To know benchmarking and relevance
8	External benchmarking Benchmarking the best in the industry Benchmarking the best in any industry	Lecture	To understand status in bigger perspective
9	Re-engineering and Information technology Flowcharting information flows Using IT to speed up processes	Lecture and case	To understand integration of technology
10	Organizing for re-engineering Obtaining top management commitment Creating cross-functional teams Supporting teams with resources	Case	To understand role of top management
11	Re-engineering – focus phase Identification of key processes Identification of key people and getting their support Identification of benefits possible and resources required	Lecture Presentation, case	To know how to get the team for BPR and Benchmarking
12	Re-engineering – design phase Selection of processes to be re-engineered Setting time frames, targets	Lecture and case	To understand phases and identification of processes
13	Re-engineering – implementation phase Communicating the benefits for the organization Communicating the benefits for the individuals Monitoring progress Consolidating the gains	Lecture and cases	To identify the benefits and results of BPR and Benchmarking

Text books

1	Re-engineering the Corporation Michael Hammer & James Champy
2	Beyond Re-engineering - Michael Hammer

Reference books

1	Business process Bench marking	Robert C. Camp
2	Process Re-engineering	Lon Roberts
3	Business process Orientation	Kevin Mc Cormack William C Johnson

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Technology Management & Manufacturing strategy**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	How technology can be used in a corporate to gain strategic advantage
2	Contribution of Technology in New product development
3	Use of technology in Product design
4	Application of Technology in a manufacturing company
5	How to compete with better Manufacturing strategy
6	Application of JIT, TOC and Customization as tools to compete in a manufacturing organisation

Prerequisites if any	operations management
Connections with Subjects in the current or Future courses	World class manufacturing, TQM, Strategic Operations Management, Project Management

Module

Sr. No.	**Content**	**Activity**	**Learning outcomes**
1	Corporate Strategy and Manufacturing. Pitfalls of functional based strategies. Strategic Integration of manufacturing and marketing. Concept of Order Winners and Qualifiers.	Lecture and Discussion	Alignment of functional strategies with corporate strategy and importance of strategy in customer orientation
2	Technology Management and New Product development (NPD). Corporate Strategy and New Product Development. Organization for NPD.	Lecture and assignment to identify new products in the market and their strategic importance to the respective organisation	Role of Technology in NPD. Strategic importance of NPD
3	Technology management and Idea Generation for NPD. Discovering customer needs. Sources for new product ideas. Market assessment and value analysis. Evaluation of new product ideas.	Lecture and Video on NPD idea generation and assignment on VA and idea generation	Process of NPD. Role of VA in NPD
4	Technology management and NPD project selection. Assessment of product concept. Assessment of competitors. Concept testing. Financial analysis of project.	Lecture and Case study on Financial analysis of project	Criteria for project selection Product concept testing process Project analysis

Sr. No.	Content	Activity	Learning outcomes
5	Technology Management and Product design. Integrated product design. Design for quality using quality function deployment. Design for reliability. Design for manufacturability.	Lecture and Assignment on QFD for different products	How QFD is used for designing new product. Product designing process Importance of designing for reliability and manufacturability
6	Order Winners and Qualifiers. Dimensions of order-winners and qualifiers- manufacturing specific, not manufacturing related. Determining order winners and qualifiers.	Lecture and discussion on distinguishing order winning and order qualifying parameters	Understanding that Order winners and qualifiers are both market-specific and time-specific. They work in different combinations in different ways on different markets and with different customers
7	Process Choice. Business implication of process choice- project, jobbing, Line batch, continuous. Hybrid processes- batch related, Line related. Technology strategy- flexibility, push vs pull, technological opportunities.	Lecture and video of different types of processes and their application	Applications of different types of processes and their advantages and disadvantages Technology strategy in relation to process selection
8	Product profiling and manufacturing. Manufacturing and product life cycle stages. Manufacturing for multiple markets. Manufacturing and incremental marketing changes.	Lecture and discussion on PLC in relation to manufacturing strategy	Relation between PLC and Manufacturing strategy
9	Focused manufacturing and group technology. Principles and concepts. Methodology. Manufacturing infrastructure. Organizational structure- specialists, generalists. Operational control- quality, inventory, manufacturing.	Lecture and discussion	Difference focused manufacturing and group technology Importance of manufacturing infrastructure Significance of Quality Control and inventory control in manufacturing
10	Make or buy. Core elements of the business and strategic considerations. Span of process and product technology. Product volumes, costs. Investment decisions.	Lecture and solving Make or buy problems	Outsourcing as strategic decision Understanding difference between process and product technology and their application in manufacturing strategy
11	Basics of world class manufacturing. General principles. Design principles. Human resource principles.	Lecture and video	Strategic significance of world class manufacturing

Sr. No.	Content	Activity	Learning outcomes
	Quality and process improvement principles. Capacity principles.		
12	Just in time Manufacturing. Principles. Practices. Time-based competition. Time as a competitive weapon. New Product Development and time to market.	Lecture and discussion	Understanding the role of Time as competitive priority
13	Mass Customization. Market trends. Pre-requisites for mass customization. Technologies for mass customization. Theory of constraints(TOC) Basics of TOC. Drum-Buffer- Rope solutions to manufacturing. TOC in project management and supply chain management.	Lecture and assignment of writing a summary of book “The goal” by Goldratt	Mass customization as a tool.Applications of Theory of constraints in operations

Text books		
1	The Goal	Eliyahu M Goldratt

Reference books		
1	Operation Management for competitive advantage	Chase- Jacobs -Acquilano
2	Manufacturing Strategy: Text and Cases. 3rd ed. Boston: Irwin McGraw-Hill, 2000.	Terry Hill

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Strategic Operations Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Importance of aligning operations strategy to corporate strategy
2	Development of operations strategy and linking market requirements to operations
3	Implementation of operations strategy
4	Various alternatives available in capacity and manufacturing process decisions
5	Understanding the importance and issues in strategic resource management
6	Role of technology in operations strategy
7	Understanding of application oriented OM tools like Process analysis, project management and ERP systems

Prerequisites if any	Operations Management
Connections with Subjects in the current or Future courses	Technology Management And Manufacturing Strategy, Operations Analytics

Module

Sr No,	**Content**	**Activity**	**Learning outcomes**
1	Introduction: Importance and linkage with corporate strategy, Strategies and values, Competing through operations. Operation strategy in global economy. Strategic alliances and production sharing, fluctuations of international financial conditions and international companies. Changing nature of world business. Quality, customer service and cost challenges and social responsibility, Current perspective- Strategic fit. Strategic Competitive priorities- Cost, Quality,Time, Flexibility	Lecture and discussion	Achieving strategic fit between corporate strategy and operations strategy and global economy, Understanding the competitive priorities
2	A framework for Operations Strategy in Manufacturing, Services. role of manufacturing /operations in business strategy: Value as business concept – strategic issues in manufacturing – Value Chain concept Focus, core competence and distinctive capabilities – stake holders & strategy	Lecture and discussion	Understanding Value chain concept , core competence and distinctive capabilities
2	Methodology for developing operations strategy :Checking markets, Outcome of market debate- Linking manufacturing to markets- strategic integration- why	Lecture and videos	Developing operations strategy. Understanding strategic issues in

Sr No,	Content	Activity	Learning outcomes
	products sell in the markets- order winners, order qualifiers. Lean systems eliminating waste.		manufacturing. Linkage between manufacturing and marketing
3	DYNAMIC MARKETS & GENERIC STRATEGIES:Technology strategy- issues in new product development -time to market- strategic nature of process- business implication of process choice- Hybrid process. Change management and sustainability.	Lecture and videos	Technology strategy, NPD, Importance of time as competitive priority Various process alternatives
4	OPERATIONS STRATEGY IMPLEMENTATION: Evaluating various tradeoffs alternatives – Focused manufacturing – Product or process focus – Make or Buy – merits /demerits – value chain approach – just in time – lean manufacturing – Quality as strategic factor	Lecture and assignments	Understanding of trade offs, make or buy decisions, JIT
5	Strategic resource management: Importance, issues involved- organizational issues operational approaches to improving delivery system, controlling operations- key performance indicator, PQCDSM(Productivity, Quality, Cost, Delivery time, Safety, Morale)	Lecture and Case study	
6	Role of technology in operations strategy: Automated production system with robotic systems. Use of IT and ITES enabling the effective strategy and resource implementation. ERP for decision making	Lecture and assignments	Understanding application of Technology in operations strategy.

Text book		
1	Chase, Jacobs, Aquilano and Agarwal, TMGH, 13th Edition	Operations Management for competitive advantage

Reference books		
1	Samson & Singh, Cambridge	Operations Management
2	Norman Gaither, Greg Frazier, Cengage Learning, India Ed.	Operations Management
3	Terry Hill 3ed. Palgrave Macmillan	Manufacturing Operations Strategy: Texts and Cases

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Industrial Engineering Applications and Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand industrial engg fundamentals in relation to production and manufacturing
2	To understand the framework of industrial engineering and its applications
3	Understand applications in service as well as manufacturing domains
4	Developing insights to manage methods and processes for an organization
5	To understand optimal utilization of resources without capital investment

Prerequisites if any	Operations Management
Connections with Subjects in the current or Future courses	Material Management, Manufacturing Resource Planning and Control

Module			
	Content	**Activity**	**Learning outcomes**
1	Introduction to industrial engg., scope and importance to improve productivity	Lecture	To know the fundamentals and scope of Industrial engineering
2	Industrial engg. Definitions and applications	Lecture & cases	To know the fundamentals and scope of Industrial engineering
3	ILO framework for industrial engg. Standards	Lecture	TO know and understand the framework internationally
4	Approach to productivity in service and manufacturing domains	Lecture and cases	To differentiate the productivity in manufacturing and service sectors
5	Overview of work study and measurement	Lecture and cases	To know how to perform Work study and measurement
6	Pre determined methods & time systems (PMTS) & application of low cost automation.	Lecture & Cases	To understand the measurements, time and cost implications
7	P,Q,R,S,T concepts in plant / shop layouts and selection of materials handling equipment and storage systems	Lecture & Cases	To know the layouts and materials handling
8	Organization Methods Applications in office and white collar productivity	Lecture & Cases	TO understand applications in business all over

Text books		
1	Work-study	ILO

Reference books

1	Industrial Engineering Applications and Management	Philip Hicks
2	Handbook of Industrial Engineering & Management	Ireson W. G. and Grand E. L.
3	Quality Detectives	Dr. Gondhalekar & Payal Shetty
4	Mathematical Techniques in Industrial Engineering	Shone K. J.

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Total Quality Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Know concept of Total Quality management
2	Know the tools for quality control and management
3	Understand relation of cost and value to business

Prerequisites if any	
Connections with Subjects in the current or Future courses	Productivity Management, Industrial Engineering Applications And Management, Operations Applications And Case Studies, World Class Manufacturing

Module

Sr. No.	Content	Activity	Learning outcomes
1	Introduction and evolution of quality movement	Lecture and case analysis	Understand concept of quality
2	Contributions of Shewhart, Deming, Juran, Feigenbaum, Crosby	Lecture and case analysis	To know and appreciate the development of quality movement
3	Contributions of Japanese pioneers Ishikawa, Taguchi, Taichi Ohno, Shigeo Shingo	Lecture and case analysis	To know and appreciate the development of quality movement
4	Statistical quality control basics	Lecture and case analysis	To understand the statistical techniques and tools for quality control
5	Basics of sampling & reliability	Lecture and case analysis	To know the methodology of sampling
6	Quality tools and techniques (Basic and advanced tools)	Lecture and case analysis , numerical	To understand techniques and tools for quality control
7	Quality Improvement and Total Employee Involvement	Lecture and case analysis	To understand role of employee and their involvement
8	JIT manufacturing and Lean manufacturing through waste elimination	Lecture and case analysis	To know Just In Time and Lean Manufacturing
9	Six Sigma tools, quality circles	Lecture and case analysis	To understand role and functioning of quality circles
10	Statistical Process control, process capability studies	Lecture and case analysis, numerical	To know how to measure the process capabilities
11	Cost of quality – Juran / crossby	Lecture and case analysis	To understand the relation of Cost and Quality

Sr. No.	Content	Activity	Learning outcomes
12	CMM / PCMM , Latest ISO, Overview of international Quality framework	Lecture and case analysis	To know different frameworks for achieving international standards

Text books

1	Total Quality Management	Dale H Besterfield, Carol Besterfield, Mary Besterfield, Sacre Glen Hhe
2	Quality Management Total Quality Management	Dr Vikram Sharma
3	Total Quality Management	Poornima M Charantimath

Reference books

1	TQM in this Service	R.P.Murthy, R.R.Lakhe
2	Total Quality	Institute of Directors
3	100 TQM Tools	Mike Asher, Gopal Kanji
4	Beyond TQM	R.L.Flood

Assessment

Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**International Logistics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Develop knowledge about international logistics and understand role of various players like logistics firms, Companies, governments, physical flow of goods, physical facilities and more importantly sources of information for international logistics.

Prerequisites if any	Logistics and Supply chain
Connections with Subjects in the current or Future courses	

Module

	Content	**Activity**	**Learning outcomes**
1	**Introduction** International Trade Volume. Historical Development of International Logistics International Logistics Definition and Components. The Economic Importance of International Logistics.	Lecture and discussion.	Understanding of International logistics
2	**Methods of Entry into Foreign Markets.** Indirect Exporting, Active Exporting. Production Abroad-Contract, Licensing, Franchising, Joint Venture, Subsidiary. Foreign Trade Zones, Maquiladoras, Foreign Corrupt Practices Act.	Lecture and discussion.	Understanding of Exports
3	**International Contracts** International Sales Contracts and CISG. Agency versus Distribution Legal Issues. Elements of an Agency or Distributor Contract. Termination and Arbitration.	Lecture and discussion.	Understanding of International contracts
4	**Terms of Trade or Incoterms** Understanding Incoterms,Incoterm Strategy,Ex-Works,Free Carrier. FAS,FOB,CFR,CIF,CPT,CIP,DES,DEQ,DAF, DDU,DDP. Electronic Data Interchange.	Lecture and discussion.	Understanding of various Incoterms
5	**Terms of Payment** Introduction,Alternative Terms of Payment,Cash in Advance. Open Account, Letter of Credit, Documentary Collection. Purchasing Cards-Procurement Cards,Tradecard.Bank Guarantees.	Lecture and discussion.	Understanding of various payment methods

	Content	Activity	Learning outcomes
6	**Currency of Payment - (Managing Transaction Risks)** Sales Contracts' Currency of Quote,the System of Currency Exchange Rates. Theories of Exchange Rate Determinations,Exchange Rate Forecasting. Managing Transaction Exposure,International Banking Institutions.	Lecture and discussion.	Understanding of importance of currency
7	**International Commercial Documents** Invoices,Export Documents,Import Documents. Transportation Documents,Electronic Data Interchange.	Lecture and discussion.	Understanding of various international commercial documents
8	**International Insurance - Insurance Glossary**. Perils of the Sea,Perils Associated with Air Shipments. Insurable Interest. Risk Management,Marine Insurance Policies, Coverage under a Marine Cargo. Elements of an Airfreight Policy.Lloyd's-Principles,Commercial Credit Insurance.	Lecture and discussion.	Understanding of Importance of Insurance.
9	**International Ocean Transportation** Types of Service, Size of vessels,Types of Vessels. Flag,Conferences,Liability Conventions, Non-Vessel-Operating Common Carriers.	Lecture and discussion.	Understanding of Ocean Transportation
10	**International Air Transportation** Types of Aircrafts, International Regulations.	Lecture and discussion.	Understanding of Air transportation
11	**International Land and Multi-Modal Transportation** Truck Transportation, Rail Transportation. Intermodal Transportation. Freight Forwarders, Project Cargo, Alternative Means of Transportation.	Lecture and discussion.	Understanding of multimodal Transportation
12	**Packaging for Export** Introduction. Packaging Objectives,Ocean Cargo.Air Transport. Road and Rail Transport, Security. Hazardous Cargo, Refrigerated Goods. Domestic Packaging Issues.	Lecture and discussion.	Understanding of Packing used in Import-Export
13	**Customs Clearance** Duty,Non-Tariff Barriers.Customs Clearing Process. Foreign Trade Zones.	Lecture and discussion.	Understanding of custom clearance process
14	**International Logistics Infrastructure** Transportation Infrastructure,Communication Infrastructure,Utilities Infrastructure.	Lecture and discussion.	Understanding of Logistics infrastructure

Text books		
1	International Logistics	Pierre David
2	Global Supply Chain Management and International Logistics	Alan E.Branch
3	Logistics in International Business	Rajiv Aserkar
4	Global Logistics and Supply chain Management	John Morgan, Chandra Lalwani

Reference books		
1	International Logistics by Pierre David – PUBLISHED BY Bizantra	
2	Logistics in International Business By Rajiv Aserkar Shroff Publishers	

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Quantitative models in Operations**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the various advance techniques of Operations Research
2	To be able to apply the above techniques for industrial applications
3	To be able to develop an art of model building to real life situation

Prerequisites if any	
Connections with Subjects in the current or Future courses	Operations Management, Operations Research

Module

Sr. no.	**Content**	**Activity**	**Learning outcomes**
1	Transshipment, Capacitated transportation, Least time transportation models	Lectures, examples on Spreadsheet, cases	To be able to understand the concepts and apply for large scale industry problems.
2	Advance LP applications in HR scheduling, investment, production planning, marketing	Lectures, examples on Spreadsheet, cases	
3	Inventory models, EBQ, EOQ under shortages and constraints, MPBS,MRP-I & II	Lectures, examples on Spreadsheet, cases	
4	Aggregate planning, level-chase-modified level & optimum strategy	Lectures, examples on Spreadsheet, cases	
5	Goal Programming formulation, Applications in investment, production, services	Lectures, examples on Spreadsheet, cases	
6	Markovian models, Applications for brand switching, debt recovery, recruitment	Lectures, examples on Spreadsheet, cases	
7	Dynamic programming and applications	Lectures, examples on Spreadsheet, cases	
8	Multi-server waiting line models & applications, Use of simulation in waiting line	Lectures, examples on Spreadsheet, cases	

Text Book	
1 N D Vohra	Quantitative techniques in Management
2 V K Kapoor	Quantitative techniques in Management

Reference books		
1	Management Science	Anderson Sweeney williams
2	H Taha	Operations Research
3	B Banerjee	Quantitative methods in OR

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Productivity Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand importance, scope and application of productivity
2	To understand linkage of productivity concept from individual, department wise & functional areas, sectors of economy, national and international economy.
3	Various approaches, measurement of productivity planning & conditions improvement as one of the competitive dimension in any business.
4	Productivity as a system approach.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

	Content	**Activity**	**Learning outcomes**
1	Concept of productivity application in manufacturing and service industries and different functional areas.	Lecture	
2	**Measurement of productivity.** Understanding improvement cycle importance of measurement like partial total factor multifactor and their applications for analysis measurement of resource production.	Lecture & application analysis	Use in decision making using calculations
3	Various models of productivity 1. Sumanths total productivity model 2. Sumanths five pronged model 3. American productivity model 4. Sink Multi factor model 5. Application by numerical.	Lecture and case studies	Using in different situation
4	Various Approaches to production. 1. Classic ILO approach 2. Kaizen/TQC approach 3. Elimination 3 MV approach 4. Participative/ Involvement 5. Creativity based	Lecture and case studies	Using in practical scenario
5	Application of new/old techniques lectures of productivity improvement & application in all area of management. 1. JIT & Lean type of production system 2. MRPI & MRPII, ERP.	Lectures & Application	

	3. TQM ISO quality systems. 4. B.P.R		
6	Learning curves. Concept, application, Quantitative, estimation, limitation	Lecture and case studies	
7	Incentives 1. Financial 2. Non financial 3. Various incentive schemes based on the group, profit sharing systems 4. Result oriented schemes 5. Calculation of incentive index	Lecture and numerical	
8	Work study 1. Method study 2. Motion & Time study 3. Works measurement 4. Objectives, method, application	Lectures & Application	
9	Value analysis & Value Engineering. 1. Concept 2. Difference 3. Procedure used 4. Importance in today's business environment 5. Various application functional areas for product process and system.		
10	People/ Enrolment/ Participation 1. Quality circles 2. Group kaizen 3. Suggestion schemes 4. Suggestion schemes 5. Small group involvement		
11	Recent production improvement techniques & applications. Use of various ratios to determine improvement in productivity.		
12	Creative based techniques 1. Brain storming 2. Whole brain thinking 3. Nominal group 4. Use in creative problem solving with practical application	Lecture role play	
13	Ergonomics 1. Concept design of work place to suit human being use of anthropometric data principles of motion economy effect of environment of productivity 2. Design of work stations use in connection with process observation. 3. Concept of muri (non value adding strin & its limitation	Lectures & Application	

Text books		
1	Productivity Technique	Dr Uday Salunkhe & Dr Srinivas Gondhalekar
2	TQM	Shridhar Bhat
3	Productivity Technique	Shirke

Reference books		
1	Work Study	ILO

Assessment	
Internal	40%
Semester end	60%

Programme - Masters in Management Studies
Semester - III
MARKETING (CORE)

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Sales Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1. To understand function of sales and its importance
2. To comprehend the art of managing the sales force
3. To motivate and manage sales force effectively
4. To develop critical thinking skills and situational leaderships
5. To learn the art of solving problems related to sales process on the field

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1	Introduction to sales organisation and types of sales force. Importance of sales management in any business organisation.	Lecture and discussion	Familiarising the student with the sales management function
2	Sales Organisation Structures, both B2B, B2C	Lecture/ Case Study	Deeper understanding about sales organisations across sectors.
3	Selling skills; Negotiation skills for services sales as against physical good sales, Sales dyads , Decision Making Units (DMUs),	Role play / observation and debriefing by faculty bringing conceptual clarity.	The students will develop an appreciation of negotiations & sales of services and physical goods
4	Sales process – sales approach, demonstration & closure, Personal selling, Applications of AIDA Model in sales.	Lecture And role play, debriefing by faculty bringing conceptual clarity.	Familiarising the students with techniques of sales process
5	Territory and time management, route planning, scheduling customer visits. Manpower planning- Recruitment, Selection, Training and development of sales personnel.	Lecture/ Role Play, debriefing by faculty bringing conceptual clarity.	Identify right attitude and skills for sales force. Developing an understanding of Territory Management.
6	Planning & forecasting techniques such as Moving	Lecture and discussion	Learn tools & techniques to set sales targets.

No	Content	Activity*	Learning Outcomes
	Averages, Trend Analysis etc. and target setting (sales budget and quota setting), using software support or Excel.	with use of templates, Also supported by guest faculty from Industry	
7	Sales Administration -Devising sales compensation, incentives, fixed and variable components of compensation, Non –monetary incentives. Performance evaluation of salesmen, setting standards of performance, recording actual performance, evaluation and managing sales meetings	Lecture/ Case Study / Role play	The student will learn how to motivated sales team and how compensation is linked to sales force performance and retention. To develop an understanding of the Art of positive evaluation
8	Sales force management during different phases which includes motivation during bad times (positive reinforcement), planning sales contests.	Lecture/ Case Study / referrals to research papers.	Developing skills to effectively manage sales force.
9	Field sales control - Sales reporting system which includes weekly, monthly, quarterly reports and interpretation of the data for future action plans, sales analysis and marketing cost analysis, sales audit, managing outstanding.	Lecture / Discussion/ Field trip	Understanding the relationships between the present sales & future plans of the organisation as well as an appreciation of costs.
10	Importance of Distribution and Logistics Management in relation to Sales Management, Understanding lead time and delivery schedule etc.	Lecture and Discussion	Learning to calculate delivery schedules.

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Sales Management, Still, Cundiff & Govani, Prentice Hall India
2	Professional Sales Management, Anderson, Hair & Bush , Tata McGraw Hill
3	Management of sales force, Stanton & Spiro Mc Graw Hill International
4	Sales Management , Futrell 6th edition Thomson South western
5	Sales and Distribution Management , S L Gupta, Excel Books India
6	Text Book on Sales Management , Dr. R.K. Srivastava, Excel Books India

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Marketing Strategy**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1. To understand and predict changes in the macroeconomic environment and its impact on marketing programmes
2. To develop an ability to respond rapidly to changes driven by consumer behaviours / new technologies etc.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1.	Introduction to Marketing strategy - Concept, Principles, Understanding of Strategy & Tactics	Lecture	Understanding the basics of Marketing strategy and tactics
2	New Product Development process • SWOT analysis, PARTS framework and design of the demand landscape • Commercialization of innovation through alliances • Challenges during the technology adoption life cycle	Lecture / Case studies / discussion	To Understand the strategic aspects of New Product Development & Commercialization
3	Marketing Intelligence • Understanding information needs for market Research • Assessment of key marketing metrics – Return on Marketing Investment; Market share and payback period; Net Promoter score; Customer satisfaction and share of wallet; Brand awareness/ preference; purchase intentions; Average Unit retail price, percentage sales on deals; All commodity volume; Inventory turns, same store sales, Cannibalization	Case studies discussions , Videos (TED Talks),Referrals to Research papers	To understand and apply various matrices to evaluate marketing programmes
3	Product and Brand Policy • Product Policy decisions – Line and Mix decisions • Managing across the product life cycle from pre-launch, pruning and withdrawal from the market • Lead users and role in product design	Lecture/Cases /Simulations	Understanding issues in formulating product and brand policies

No	Content	Activity*	Learning Outcomes
	• Brand Culture – Aligning with organizational culture		
4	Pricing Policy • Pricing strategies – Types of pricing strategies: Cost-plus, Perceived value, etc. • Price band – Types and width of price bands and its management • Using promotions as a lever to manage the price band	Lecture/Cases	To understand levers to manage prices.
5	Marketing Plan • Situation Analysis – 5C's analysis (customer/competitor/collaborator/company/context); • Forecasting societal changes based on PEST analysis • Preparing and Presenting the Marketing plan	Cases and Field Assignments	Formulating a Marketing Plan.
6	Channel Policy • Designing the length, breadth, and modifying the dimensions of the channel • Need for control and availability of resources and role in channel design • Channel selection strategy – direct, corporate, contractual systems • Omni-channels • Channel conflicts and resolution	Lectures/Cases/Games (Beer Games)	Understanding the issues in the design and management of channels

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Marketing Strategy, Walker Mullins Boyd & Larreche, Tata McGraw-Hill
2	Marketing Strategy, Luck & Ferrell, Southwestern
3	Marketing Strategy, Stephen Schnaars, Free Press
4	Marketing Metrics, Reibstein , Farris , Bendle, Pfeifer, Pearson
5	Strategic Marketing, Dr.Shahjahan
6	New Product Policy & Plans , Yoram Wind
7	Lead Users, Eric Von Hippel

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Consumer Behaviour**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives:

1. An understanding of the pre and post purchase consumer behaviour.
2. To develop conceptual insights into key aspects such as social, psychological and other factors that influence consumer behaviour.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No	Particular	Activity*	Learning Objectives
1	Consumer Behaviour: Introduction, definition and impact of digital revolution and importance to marketing.	Interactive Lecture	To understand 1. Concept of consumer behaviour, Role and importance of consumer behaviour to a marketer 2. How consumer behaviour has changed due to digital revolution
2	Models of consumer behaviour and their marketing implications: The economic model, Learning model, Psychoanalytic model, sociological model, Howard Seth Model of buying behaviour, The Nicosia Model, The Engel-Kollat-Blackwell Model, Decision Making Model	Lecture	To understand models of consumer behaviour
3	Motivation: Definition, types of motives, (Positive and Negative Goal, negative goal, Rational versus Emotional Motives), Discovering Purchase Motives Theories of motivation, Maslow's hierarchy of needs and its relevance to consumer behaviour and marketing strategy; the physiology of technology on consumer behaviour.	Interactive Lecture, Case study and consumer survey	To understand the psychological and physiological aspects of consumer behaviour

Sr. No	Particular	Activity*	Learning Objectives
4	Absolute and differential thresh hold, Internal and external factors affecting perception, Gestalt Psychology, subliminal perception, Consumer Imagery, Zaltman metaphors to understand attitude towards products	Interactive Lecture, Quiz and consumer survey	Marketing applications of consumer perception theory.
5	Learning and Information Processing and its impact on behaviour.	Interactive Lecture, and consumer survey	To understand consumer learning processes and its impact on consumer behaviour
6	Attitudes: Concepts and Models- Cognitive Dissonance, Tri-component Theory, Multi attribute model, Attitude and market segmentation, product development strategies and attitude change strategies.	Interactive Lecture, Case study	To understand the various models pertaining to consumer attitudes and their impact on marketing
7	Personality: Meaning, nature, definition and characteristics, Theories of Personality (Freudian theory, Trait Theory, Jungian Theory) Self-image and self-concept, VALS model and segmentation, Personality and consumer behaviour.	Interactive Lecture, Case study and consumer survey	To understand the development of personalities through different theories
8	Social Class: concept of social class, homogeneity of needs in social class, social class stratification in India New SEC/ NCAER, classification of the society, Influence of social class on purchase behaviour.	Interactive Lecture/Cases /McKinsey Global Institute Reports (The Bird of Gold)	To understand the consumption behaviour of social classes.
9	**Group Behaviour**: Reference Groups and its influence on consumption, Diffusion of innovation process, Consumer Adoption of new products, Impact of social media on formulating opinions on products and brands. **Family**: Role of family in decision making and consumption process.	Interactive Lecture, and quiz/referrals to research papers	To understand the influence of groups and families on the diffusion of innovation and adoption of new products.

Sr. No	Particular	Activity*	Learning Objectives
10	**Culture and Subcultures**: Understanding the influence of culture, norms and their role, traditions and value system, Indian core values, cultural aspects of emerging Indian markets.	Interactive Lecture, and Case discussions	To understand impact of cultures and values on Indian consumer.
11	**Post purchase behaviour**: Post purchase evaluation and disposition towards the product, Post purchase satisfaction measures	Interactive Lecture, cases and consumer surveys.	To understand issues in Post purchase decisions
12	**Organization buying process:** Nested segmentation, Role & Power of Buying centres (Initiators, Influencers, Deciders, Buyer & Gatekeepers). Buying decisions based on ABC / VED / FSND analysis.	Interactive Lecture/Cases	Understanding the B2B buying process

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain including consumer research methods and reports wherever applicable.

Recommended Books

1	Consumer Behaviour, Schiffman & Kanuk and S Ramesh Kumar,10th edition Prentice Hall India.
2	Consumer Behaviour, Loudon & Della Bitta, 14th edition Tata McGraw Hill
3	Consumer Behaviour in Indian Perspective- Text and Cases, Suja R. Nair, Himalaya Publication House.
4	Consumer Behaviour Building Marketing Strategy, Hawkinds David Mothersbaug & Amit Mookerjee, 11 th edition, McGraw Hill International edition.
5	Consumer Behaviour Text & Cases, Satish Batra & S.H.H.Kazmi
6	Marketing Models , Gary L.Lilien, Kotler, Moorthy, Eastern Economy Edition

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Services Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

1	To familiarize students to basic concepts and decision making processes involved in Services Management
2	To help students to understand application of these concepts to various industries in service sector

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No	**Content**	**Activity***	**Learning Outcome**
1	Introduction – Difference between Products & services, Key characteristics of services	Lecture	Students will be able to understand Fundamentals of services
2	Consumer Behaviour in Services	Lecture	Students will be able to understand Consumer Behaviour in Service industry
3	Services Marketing Mix decisions- 7Ps, SERVQUAL model	Case / Lecture / Assignment / Field survey	Students will be able to understand Gaps in service delivery
4	Managing Demand, capacity & service assets	Class Room Teaching, Case Study Discussion	Students will be able to understand how to forecast demand, Planning delivery and capacity by using service assets of an organization
5	Managing Customer Relationships- CRM as a tool for customer satisfaction and retention, service blueprints – moments of truth, Leaking bucket theory	Lecture / Case Study Discussion	Students will be able to understand use of CRM in customer satisfaction and retention
6	Complaint handling , Service Failure & Service Recovery	Lecture / Case Study Discussion, Role Play	Students will be able to understand how to use complaints as an opportunity for service recovery and enhance customer loyalty
7	Improving Service Quality ,	Lecture /	Students will be able to

Sr. No	Content	Activity*	Learning Outcome
	Service Marketing triangle, Fishbone Diagram	Case Study Discussion, Role Play	understand how Companies align internal capabilities to deliver external promises for customer loyalty
8	New developments in service marketing –Peer to Peer sharing (Airbnb , Uber , Ola)	Presentation from Students and evaluation on the basis of topic clarity	Students will be prepare for service sector by evaluating, giving feedback on their presentation for service sector organizations

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Services Marketing International Edition –Zeithamal V., M. J. Bitner and D.Gremeler
2	Services Marketing – Text and Cases – Rajendra Nargundkar, 2nd Edition by McGraw-Hill Companies
3	Services Marketing by Lovelock, Wirtz & Chatterjee 7 edition
4	Services Marketing, Indian Edition By Valarie A Zeithmal, Dwayne D Gremler, Mary Jo Bitner, Ajay Pandit

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Core**			
Title of the Subject / course	**:**	**Product and Brand Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1. To expose and sensitize the students with the practices of product and brand management.
2. To understand the key issues in Product and Brand Management

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes	No of Session (3 Hrs)
1	Introduction to Product Management, Role and Functions of Product Managers	Lecture and discussion	Understanding the functions of Product Management	1
2	Product Mix and SBU Strategies, Portfolio analysis (BCG / GE Multifactor Matrix)	Lecture	Understanding the portfolio analysis and tools.	2
3	Product Decisions over the PLC	Lecture/Case Study discussion	Understanding the relationship between Product strategy and PLC	1
4	New Product Development Process	Lecture/Project-Assignment/Case study discussion	Understanding NPD process	2
5	Financial Decision on the PLC using Polly and Cook Model	Lecture	Understanding the Financial Implications across PLC	1
6	Introduction to Brand Management- Branded House Vs House of Brands, Corporate Brand.	Lecture/Case study and discussion.	Understanding the fundamentals of Brand Management	2
7	Brand prism by Kapferer Model, Brand Anatomy.	Lecture/ Case Study	Understanding Brand development process	1
8	Branding Decisions- Line Extensions, Category Extension	Lecture/ Case Study and discussion	Understanding Branding Decisions	2

No	Content	Activity*	Learning Outcomes	No of Session (3 Hrs)
9	Brand Equity – Concept and measure	Lecture	Understanding Brand Equity and its measure	1

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Strategic Brand Management by Kevin Lane Keller, M G Parameswaran, Isaac Jacob, Pearson
2	Brand Management by David Aaker, Tat McGraw Hill
3	Brand Management-Indian Perspective by YLR Murthy, Vikas Publishing

Assessment

Internal	40%
Semester-end	60%

Programme - Masters in Management Studies
Semester - III
MARKETING (ELECTIVES)

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Retail Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives:

1 To develop the analytical ability of the students to attain an insight into Retail Management contexts

2 To Understand the techniques for optimal utilization of resources

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	**Content**	**Activity***	**Learning Outcomes**
1.	**An Introduction to Retailing:** Factors Influencing Retailing, Basic Retail Models, Modern Retail format & Retailing in rural India	Lecture / Field visits	To Understand basics of Retailing
2.	**Strategic Planning in Retailing:** Setting up Retail organization, Site analysis**,** Store Design / Layout, Cost & inventory control, Designing an information system for retail, Store based Strategy Mix, Store branding and Promotions	Lecture / Field visits	Understanding the Key elements in Retail planning process
3.	**Retail Formats :** Types, E-tailing, Ownership structures	Lecture / Projects	Understanding Different Retail formats
4.	**Retail Supply Chain :** Issues in managing supply chains Networks, Demand Forecasting, sourcing & vendor selection, Overall Inventory Management	Lecture / Cases	Understanding issues in supply chain
5	**Store Operations** Store Atmosphere, In-store service, Visual Merchandising, Store-wise inventory Management	Lecture / Site Visit	Understanding the customer experience and engagement
6	**Identifying and Understanding Consumers:** Trade area analysis- Huff Model, Radial studies, Gravity Models, & Drive-time analysis.	Lecture / Cases	Understanding market segmentation

Sr. No.	Content	Activity*	Learning Outcomes
	Segmentation of consumers, Consumer perception and Behaviour & Shopping culture		
7	**Pricing in Retailing :**Types of Pricing, Decoy Pricing, Bundle Pricing, EDLP, High-low Pricing, Loss leader pricing, Dynamic Pricing	Case Study Discussion	Understanding Pricing strategy
8	**Web-based Retailing :** Technological Aspects, Economics of platforms challenges in managing platforms	Cases (Suggested Amazon, Flipkart etc.)	Understanding Web-based retailing
9	**Retail HRM :** Identifying Manpower requirements, Recruitments, Selection & training	Lecture	

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1.	Retail Management – Chetan Bajaj; Rajnish Tuli; Nidhi Varma - Oxford
2.	Fundamentals Of Retailing - K. V. S. Madaan -Tata McGraw-Hill Education
3.	Retail Management: A Strategic Approach, - Berman - Pearson Education India
4.	Retailing Management - Swapna Pradhan - Tata McGraw-Hill Education
5.	Marketing Your Retail Store in the Internet Age - Bob Negen, Susan Negen Wiley
6.	Retail Marketing and New Retail Idea - Marks & Spencer - Sven Hallbauer - GRIN Verlag
7.	International Retail Marketing: A Case Study Approach - Margaret Bruce, Christopher Moore, Grete Birtwistle - Elsevier Butterworth-Heinemann,
8.	Strategic Retail Management: Text and International Cases - Joachim Zentes, Dirk Morschett, Hanna Schramm-Klein - Springer Science & Business Media

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Rural Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

1 To develop an understanding of the rural economy of India
2 To develop a marketing program for rural consumers

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcome
1	Introduction to Rural Marketing – Demographics and psychographics of rural India, Land use patterns, Health care, etc.	Lecture	An overview of rural India
2	Rural Environment – Socio Economic, Cultural and Political Aspects, SHG, Microfinance, NABARD, RRBs, State cooperative banks Governmental Development Programmes, Mahatma Gandhi National Rural Employment Guarantee Act (MN REGA)	Lecture / Case Studies / Articles	Analyse rural India and drivers of rural demand
3	Rural Consumer Behaviour : Characteristics of rural consumer, Factors affecting rural consumer behaviour	Lecture	Understanding how rural consumers behave and what factors affect their behaviour
4	'4As of rural marketing-mix'	Lecture	Understanding the 4P's in rural context
5	Rural Distribution: Challenges & Opportunities	Lecture / Case studies	Understanding the issues related to rural distribution
6	Communication in Rural India	Lecture / Case studies	Enable students to appreciate the various media for reaching rural
7	Marketing of Agri Input and Rural Produce & Services Marketing (Agricultural & Non-agricultural)	Lecture / Case studies	Understanding marketing of rural oriented products g & services
8	Proliferation of technology in Rural India	Lecture / Case studies	Understanding the scope of technological application in rural India
9	Social Entrepreneurship – Opportunities & Challenges	Lecture / Case studies	Understanding the scope of Social Entrepreneurship in rural India

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Pradeep Kashyap, (2007) : IInd Edition, The Rural Marketing Text Book
2	Ravindranath V. Badi & Narayansa V. Badi (2014) IIIrd Edition , Rural Marketing Text Book; HPH

Note: A credit based project to visit rural India and learn the various aspects covered in the classroom course thereby making students to experience it in the rural environment.

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Marketing Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

1 To develop an understanding of the rural economy of India
2 To develop a marketing program for rural consumers

Prerequisites, if any

Knowledge of Specific Skills	**MS Excel**
Software Platforms	**SPSS, Tableau, SAS, R (at least one or similar)**
Expertise required	**The institute would need the services of industry experts as they would have access to database.**

Module

No	**Contents**	**Activity (only a guideline and not exhaustive)**	**Learning Outcome**
	Unit I (30% weightage)		
1	Pricing, Breakeven and Margin Analysis, Demand Estimates, Marketing Budget and Marketing Performance Measure, Marketing Metrics and its application	Case study/Projects	The students learn and understands how to work out pricing, breakeven analysis, and framing of marketing budgets.
2	Financial Implications of various Marketing Strategies	Problems	To understand the financial implications of various marketing strategies through examples.
3	Cross Tabulation, Chi square Test, T Test, ANOVA (F Test), Simple and Multiple Regression	Recap	Recap for students who are assumed to be already familiar with these techniques.
4	Financial Feasibility analysis using NPV method, Customer Life time Value (CLTV)	Case Study/real time projects	To analyse the financial feasibility of a project. The students will be able to calculate the CLTV measure based on specific inputs.

No	Contents	Activity (only a guideline and not exhaustive)	Learning Outcome
	Unit II (40% weightage)		
5	Descriptive Analytics a. Geographical Mapping. b. Data Exploration. c. Market Basket Analysis	Case Study/real time projects	To understand how external data sources are used on top of internal data sources to derive better insights. The students will learn how data exploration is used in real world problem solving. The students will be able to understand the application of Market Basket Analysis from the analytics view point.
6	Forecast Analysis a.Moving Averages b.Time Series Forecasting Using Linear Regression	Case Study/real time problem solving	To understand moving averages method and apply with the purpose of forecasting.
7	Predictive Analytics Model for Marketing a.Clustering models (segments) b.Propensity models (predictions)	Case Study, Industry data	The student will understand and apply specific statistical and regression analysis methods to identify new trends and patterns, uncover relationships, create forecasts, predict likelihoods, and test predictive hypotheses. Understand clustering models, product based and brand based clustering. Understanding propensity model.
8	Social Media Marketing Analytics a. Data mining methods b. Analyses for websites, search engine results, and social media, e.g., Twitter, Facebook, and blogs. (Audience size, Reach & Engagement, Traffic, Community responsiveness)	Case Study, Problems/As per requirement	Understanding of the Complete dynamics of analytics in the digital technology and social media landscape. Learning the business/economic aspects of social media analytics and its application in the real world marketing scenarios.
9	Digital Analytics/ Google Analytics a. App usage , App revenue, retention, churn analysis b. Mobile Analytics (Example- Amazon Mobile Analytics)	Case Study, Problems/As per requirement	Student will learn to understand and control his on line campaign spend and performance. Student will learn how to track numbers and sources of mobile app customer acquisition, retention, referrals.

No	Contents	Activity (only a guideline and not exhaustive)	Learning Outcome
	Unit III (30% weightage)		
10	Conjoint Analysis	SPSS/As per requirement	Students will learn the need for conjoint analysis and their applications in designing of a new product or service.
11	Factor Analysis	SPSS/As per requirement	Students will understand the concept of factor analysis, different methods of factor analysis and the interpretation of factor solutions with emphasis on exploratory factor analysis , confirmatory factor analysis and structural equation modelling
12	Cluster Analysis	SPSS/As per requirement	Students will understand the need for cluster analysis, how to retain the correct number of clusters and interpret cluster solutions.
13	Discriminant Analysis and Multi-Dimensional Scaling	SPSS/As per requirement	Students will learn the different types of input to create perceptual maps and pat worth utilities and the interpretation the solution of discriminant analysis and MDS for business applications.

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable

Recommended Books

1	Marketing Analytics: Strategic Models and Metrics by Stephan Sorger, Admiral Press.
2	Marketing Analytics: Data-Driven Techniques with Microsoft Excel by Wayne L. Winston, Wiley
3	Marketing Metrics - Manager's Guide to Measuring Marketing Performance by Neil T Bendle, Paul Farris, Philip E Pfeifer, David J Reibstein, Pearson Education

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Digital Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives:

1. To understand the new media, Different types, their strengths and the way customer interacts with new / digital media.
2. To develop the skills to strategize and execute campaigns on new / digital media

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1	Introduction to digital marketing – types of digital media, industry trends, Indian media spends, comparison with traditional media	Lecture, industry reports	To understand the growing importance of digital media in comparison with traditional media
2	Customer consumption trends of digital media Role of digital media in consumer decision making process Behavioural and Contextual targeting	Lecture/ Case Study	To understand how consumers interact with digital media and use the same for marketing strategies
3	Search Engine Optimization (SEO) • Need for SEO • Strategies • Method • Integration with Google Analytics, analysis of reports and metrics	Lecture, Case Study and practical demonstration of creating SEO friendly content.	Familiarizing the students with techniques of SEO and metrics important for a website through Google Analytics
4	Search Engine Marketing (SEM) • Importance and need • Campaign strategy • Identifying keywords and their configurations • Creating AdWords campaigns • Assess campaign using AdWords analytics reports	Lecture & practical demonstration of AdWords Campaign	Appreciate the search engine advertising and learn to make strategies for effective campaign. Understand the various metrics important for SEM campaign
5	Social Media Marketing • Introduction & comparison of various Social Media (including subscriber base, features, popularity etc.)	Lecture & practical demonstration of Campaign on Facebook / LinkedIn /	To be able to build brand preference, generate leads and aggregate audience on Social Media and increase audience engagement. Understanding Social media

No	Content	Activity*	Learning Outcomes
	• Social Media Marketing strategies – with examples/ cases • Content Strategy for various social media • Creating Campaign on Social media (Facebook) • Assessment of campaign using Facebook analytics	Twitter / Instagram / Snapchat etc.	analytics and make relevant strategies
6	Display advertising Video advertising - types and their effectiveness Blog marketing	Lecture/ Case Study/ Videos	To be able to use display advertisement, blogs and YouTube in overall marketing strategy
7	Pricing Models • Cost per Click (CPC) • Cost per thousand Impression (CPM) • Cost per acquisition (CPA) • Relevance of each in different situations • Prevention of click frauds	Lecture/ Case Study	Students will understand the different pricing options, and their use in given scenario
8	Email Marketing • Trends, types, Challenges • Planning & designing campaign • Assess effectiveness of the campaign using various metrics	Lecture/ Case Study	To deliver relevant marketing communication to targeted audience in most creative way. Apply learnt skills n effectively building users list, deliver email and generate relevant clicks
9	Mobile Marketing • Market size, growth etc. • Applications • Coupons • Gamification • Mobile wallets • QR codes • USSD • SMS	Lecture/ Case Study/ Videos	Strategizing marketing through smart devices. Learn app- based marketing, QR codes, Location based Marketing, SMS marketing and effective use of mobile wallet ecosystem
10	E-commerce • Understand trends and profile of e-commerce players • Use of e-tailers for promotion and distribution of brands • Strategies used by E-commerce players	Lecture/ Case Study/ Videos	

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	The Art of Digital Marketing – Ian Dodson – Wiley Publication
2	Digital Marketing – Vandana Ahuja – Oxford Publication
3	Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation – Damian Ryan – Kogan Page
4	Digital Marketing: Strategy, Implementation & Practice – Dave Chaffey & Fiona Ellis-Chadwick
5	Convert! Designing Websites For traffics and Conversions – Ben Hunt
6	The Social Media Bible: Tactics, Tools & Strategies for Business Success – Lon Safko
7	Global Content Marketing – Pam Didne
8	The Power of Visual Storytelling – Ekaterina walter
9	Digital Marketing – Dr. Hari Krishna Maram

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Customer Relationship Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives:

1. To provide insights into CRM concepts and its applications in maximising customer lifetime value.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1	Introduction to CRM, Levels of CRM, CRM and its integration processes in organisation.	Lecture / Discussions	Familiarising the students with the concept of CRM
2	Know your customer in terms of target group, Voice of customer, Customer Care, Customer Value, Customer Touch Points, Customer Portfolio Analysis.	Lecture and Discussions using Case Studies	Deeper understanding on "Who the Customer is"
3	Customer life cycle and customer life time value, Recency, Frequency, Monetary analysis	Lectures/ Case Study	Measuring Customers and identifying profitable customers
4	Importance of Customer Acquisition and Retention by Loyalty programs, impact of churn-rate and profitability, Loyalty ladder.	Lecture, Case Study and Assignments	To appreciate the Importance of acquiring and retaining customers.
5	Relationship marketing, building brands using relationship marketing.	Lecture and Case Study	To understand relationship marketing and Its role in brand building.
6	CRM in B2B and B2C markets considering requirements in service and manufacturing sectors.	Lecture and Case Studies	To understand CRM in different Sectors
7	CRM Implementation road map, Operational Issues.	Lectures	To understand implementation issues and road map
8	eCRM, Meaning, Essence, Difference with CRM, eCRM Process, Implementing and Integration with other processes, Steps in E CRM process.	Lecture and Case discussions	Understanding eCRM process.
9	Technology, Modules and Sub modules of a CRM software, Cloud Technology (SAAS, PAAS etc), Virtual Technology.	Lecture	To develop conceptual knowledge of technological tools used in CRM.

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable

Recommended Books

1	CRM Hand Book A Business Guide to Customer Relationship Management 1st Edition by Jill Dyché Addison- Wesley
2	Customer Relationship Management: A Strategic Perspective,G. Shainesh, Jagdish N Sheth, Macmillan
3	CRM, Urvashi Makkar & Harinder Kumar Makkar, Tata Mc Graw Hill Education Private Ltd
4	CRM Concepts and Cases second edition, Alok Kumar Rai, PHI
5	Implementing SAPCRM The Guide for Business and Technology Manager, Vivek Kale, CRC Press

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Marketing Research & Analysis**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	This course is designed to acquaint students with the marketing research process, applications and statistical tools & techniques
2	This course will help students explore different approaches of Marketing research and acquaint them with contemporary marketing research practices.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No	Content	Activity*	Learning outcomes
1	Introduction to Marketing Research. Need & Scope of Marketing Research. Structure of Marketing Research studies. The Marketing Research Process.	Lecture	To understand the purpose of marketing research. To describe a marketing information system and explain how it differs from marketing research. Be familiar with various stages of the marketing research process.
2	Qualitative Analysis - Brainstorming, Focus Groups, In-Depth Interviews, Projective Techniques, Attitude and motivation research, Concept under tests.	Lecture	Understand the fundamentals of Qualitative research.
3	Primary Research - Various aspects such as scales, questionnaire design, sampling frame & technique Secondary Research – Secondary and Standardized sources of Marketing Data Primary & Secondary sources of Secondary Data Analysis	Lecture/Assignment (Primary Research- Developing questionnaire & pilot testing Secondary research – Literature review and make a summary)	Recap of understanding which the students gained in Business Research Methods

Sr. No	Content	Activity*	Learning outcomes
4	Market segmentation, Positioning Research, Product/Price/Promotion/Distribution research, Sales Promotion Research Campaign Tracking Research	Lecture/Case study	Understand the process of marketing mix research
5	Advertising Research, Concepts of copy testing and ad tracking, Ad recall, Ad Comprehension, Stages involved in Advertising research, Types of advertising media research- Print, Out-door, TV/Cinema, Mobile outdoor media,	Lecture	Understand the various aspects of Advertising research.
6	Brand research - Brand Equity Research Brand Valuation Research Corporate Image Measurement Research	Lecture / Discussion/Learning support by industry expert.	Understand the applications of brand research
7	Understanding and Application of Tools used for Marketing Analysis a. Forecasting Models b. Discriminant Analysis c. Logistic Regression d. Cluster Analysis e. Multidimensional Scaling f. Conjoint Analysis	Lectures with SPSS	Understand the application of statistical tools and techniques to marketing problems using SPSS.(Techniques like regression analysis, factor analysis are already covered in business research methods)

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable

Recommended Books

1	Marketing Research –Hair, Bush, Ortinau (2nd edition Tata McGraw Hill)
2	Marketing Research Essentials – McDaniels & Gates (3rd edition SW College publications)
3	Marketing Research – Sunanda Easwaran and Sharmila J Singh – Oxford Publications Marketing Research – Nigel Bradley – Oxford Publications
4.	Marketing Research Essentials – McDaniels & Gates (3rd edition SW College publications)
5.	Marketing Research – Zikmund & Babin – Cengage Learning
6	Marketing Research – Aaker, Kumar, Day (9th edition John Wiley & Sons)

7	Marketing Research – Burns , Alvin, Bush, Ronald (5th edition Prentice Hall)
8	Marketing Research – An Applied Orientation – Naresh K Malhotra – Pearson Publications
9	Marketing Research for managers -3rd Edition by Sunny Crounch & Mathew Housden - A Butterworth-Heinemann Title
10	Marketing Research (Macmillan) - Rajendra Nargundkar

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Event Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

1 To familiarize students the basic concepts and decision making processes involved in Event Management

2 To develop the conceptual & management skills at various levels in the area of overall event management; which will enable students to analyze, develop, conceptualize and formulate strategies in marketing of events

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No.	Content	Activity*	Learning Outcome
1	**Introduction** of Event Management concepts, Advantages, Types of events, Role of events in business promotion; MICE elements	Lectures	To understand basic concepts of event management
2	**Event Concept & Design –** SWOT analysis, PESTEL Analysis, Elements of event, Establishing viability of the concept, Designing of the event.	Lectures/ Case Study Discussion	Developing a conceptual framework for events.
3	**Event Planning** (operational perspective): Event Objective(s), Theme based event conceptualization, Event proposal, Event protocol, Planning Tools, Legal compliance;	Lectures/ Assignment	To understand various aspects of planning events from the perspective of execution.
4	**Event Financial Planning** – Budgeting, Break-even projection, Contingency fund & Profitability analysis.	Lectures/ Fieldwork/ Assignment	To understand the financial aspects of conducting an event
5	Focus on Standard operating Procedures & Checklists: Venue; Timing; Guest list; Invitations; Venue dressing; Equipment and facilities; Guest of honor; Speakers; Media; Photographers; Podium etc.; Celebrity endorsement; Staff recruitment and training; Catering; Health and safety issues; Insurance; Delegation and vendor management.	Lectures/ Fieldwork	Compliance of requirements for successfully organizing an event.

No.	Content	Activity*	Learning Outcome
6	**Event Marketing:** Characteristics of Event Marketing, Event Sponsorship**.**	Lectures/ Case Study/ Role play	To develop an understanding of event marketing
7	**Event Coordination and Control** - Event Staffing – Recruitment & Selection; Training & briefing; Crowd Management; Operations & Logistics; **Event Evaluation** – Tools, Steps and Reason for event evaluation.	Lectures/ Role Play/ Field visits	To understand how event management companies align their capabilities to deliver customer satisfaction
8	**Trade Fairs -** Objectives, Importance in B2B/B2C marketing, Branding and Communication	Lectures/ Trade fair Visit	Students will get practical exposure to all aspects of trade fair(s)

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable

Recommended Books

1	Event Management - Lynn Van Der Wagen, Brenda R. Carlos [Pearson Education]
2	Event Planning & Management – Diwakar Sharma [deep & Deep Publication Pvt. Ltd.]
3	Event Management – Dr. Ashutosh Chaturvedi [Global india publications Pvt. Ltd.]

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Healthcare Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

1 To understand trends and opportunities in the health care sector
2 Formulate marketing strategy and tactics for the health care sector

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	**Content**	**Activity***	**Learning Outcomes**
1.	Introduction & Scope of Health Care and Wellness Sector in India.	Lecture	To introduce the students to health care sector
2.	Introduction to the Health Care Policy of Government of India - Jan Aushadhi Stores (JAS), NITI Aayog (National Institute for Transforming India) Initiatives, National Dialysis Services Programme Sehat' (Social Endeavour for Health and Telemedicine)	Lecture Project on any one Government Scheme	To sensitize students to Government policies pertaining to health care
3.	Wellness Sector- Overcoming Challenges of different stakeholders (Users, Providers, Government & Educationists)	Lectures/Cases	Understanding the challenges peculiar to wellness sector
4.	Market forces and its effect on the health care and wellness industry- Consumers & Patients (for different segments), Economy & Finance (Affordability and Medical insurance), Information Technology and e-Health (Hospital Information System, E-CRM, Unorganised Health care providers Vs Organised health care providers, Government, Trust and Private health care providers, Government Policies, Workforce beyond doctors,	Lecture/case study	To understand various market forces and its linkages with Healthcare sector
5.	'3 Cs and 4 Ps' for the health care and wellness industry.	Lecture/ Case study	Integration of marketing concepts with health care
6.A	Analysing the customer: (on various parameters like-	Lecture, Project on	Understanding different segments in Healthcare

Sr. No.	Content	Activity*	Learning Outcomes
	Poor Health Status, Younger, Health, conscious, High Income, Corporate etc.	healthcare and wellness needs of any two types of customers	services
6.B	Customer Retention: Service and wellbeing, Loyalty Plans, Membership to wellness and health care plans	Lecture, Study on any loyalty plan of a hospital or wellness provider	Understanding CRM strategies for customer
7	Partnering with Insurance Providers: Role of TPA's, Role of other stake holders in Medical Insurance, Role of Hospital in Insurance supporting, Medical Insurance Providers, Ethics and other issues	Lecture, Guest lecture form health insurance	Understanding the role of IRDA and insurance companies in healthcare sector
8	Importance of Corporate tie-ups for Health Care and wellness providing: Corporates policies on health and wellness , Pricing for Corporates, Mutual benefits to Corporates, Hospitals and Care receivers	Lecture, Visit to a Corporate Hospital	Understanding importance of corporate tie-ups in healthcare sector
9	Role of the General Physician /Family Doctors /Neighbourhood Doctor in referral marketing of healthcare services	Lecture, Project on role of GP/FD in the health care sector of India	

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1. Essentials Of Health Care Marketing- Eric N. Berkowitz - Jones & Bartlett Learning
2. Cases In Health Care Marketing - John L. Fortenberry Jr. - Jones & Bartlett Learning
3. Heath Care Marketing – Tools And Techniques - John L. Fortenberry Jr. -Jones & Bartlett Learning
4. Wellness Management A Lifestyle Approach for Health, Fitness and Energy - Rajasekhar Kali Venkata – Notion press
5. Health Service Marketing – A Practitioners Guide - Richard K. T. - Springer New York

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Distribution and Supply Chain Management (SCM)**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

1. To develop an understanding of the role of distribution and supply chain in marketing and its importance in creating value to the customer.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity*	Learning outcomes	No. Session
1	Strategic issues in channel decisions	Lecture and Case Discussion	Understanding the various elements in channel decisions	1
2	Issues in channel design : Resources Vs need for control, types of product, consumer behaviour, modification of channel.	Lecture and Case Discussion	Understanding of channel design	1
3.	Managing channel conflicts – Goal conflict, Role conflict, Communication failure. Building strong brands, demand pull, carrot and stick	Lecture and Case Discussion	To understand Key challenges in managing conflicts	1
4.	Types of channels, Wholesaling, retailing, flows in channels of distribution, distribution analysis and control.	Lecture and Case Discussion	Understanding different kinds of channels and control aspects.	1
5.	Supply chain – Objective, Importance and Process flows, Bull-whip effect.	Lecture and Case Discussion	Understanding basics of supply chain	1
6	Demand forecasting – different methods of forecasting (Time series, moving averages)	Lecture and Case Discussion	To understand how to forecast demand	2
7	Sourcing decisions in supply chain – In house Vs outsourcing decisions,	Lecture and Case Discussion	Understanding negotiations and sourcing decisions	2

Sr. No.	Content	Activity*	Learning outcomes	No. Session
	supplier selection – auction and negotiations			
8	The procurement process, sourcing planning and analysis, benchmarking the supply chain and managing global supply chains	Lecture and Case Discussion	Understanding key issues in managing supply chains.	2
9	Technology and supply chains – 3D printing and its impact, Material sciences (Development of alternate materials)	Lecture		2

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Logistical Management Donald J Bowersox
2	Strategic channel management by Bowersox & Cooper
3	Physical Distribution Management Logistical Approach Dr.K.Khanna
4	Logistics and Supply Chain Management by Martin Christopher, Pearson
5	Sales and Distribution Management by Krishna K Havaldar and Vasant Cavale
6	S. L. Gupta: Sales and Distribution Management, Excel books

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Tourism Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives:

To understand the application of marketing concepts to the tourism industry.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity*	Learning Outcomes
1	Introduction to various sectors of the Indian Tourism Industry (Domestic / International tourists) such as medical tourism, pilgrimage, wildlife, Tournaments, etc.	Lectures	To understand the potential of India for domestic and foreign tourists.
2	Segmentation of the tourism market in India and positioning as an attractive destination for Domestic and Foreign tourists	Lectures / Case discussions	To understand the application of STP in tourism marketing
3	Role of Government in tourism marketing. Tourism ecosystem such as trained guides, reliable public transportations, availability of hotel rooms of different categories etc. as the drivers of the tourism industry.	Case study discussions and Field visits	To understand the application of ecosystem concept in tourism marketing
4	Pricing and Promotion strategy : Differentiation on the basis of tour packages, themes, and pricing on perceived value	Lectures and case discussions	To understand the interplay between pricing and the totality of service offerings / value propositions.
5	Channel strategy, various franchisees formats such as B2B, B2C, and C2C. Targeting customers through exhibitions, promotions (offline and online), placement in movies etc.	Lectures / Cases	To understand the role of channels in tourism.

Sr. No.	Content	Activity*	Learning Outcomes
6	A study of some success stories in Indian tourism – Medical tourism, Religious tourism.	Lectures / Cases	To gain lessons from success stories and try to extrapolate them to other sectors in tourism
7	Gap analysis in various sectors of tourism industry SERVQUAL Model	Lecture / Assignment	Understanding Gaps and remedial actions in service quality in the tourism industry.

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Fundamentals of Marketing	Stone, Marilyn A. and Desmond, John. (Routledge)
2	Marketing Management: Planning & Control	Ramaswamy V.S. and Namakumari. S (Macmillan)
3	Tourism Marketing	Chaudhary, M (Oxford University Press)
4	Introduction to Travel and Tourism Marketing	Bennett J. A and Strydom, J.Wilhelm (Juta Education)

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**III-Elective**			
Title of the Subject / course	**:**	**Marketing of Banking & Financial Services**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

To develop an understanding into the concept and practices in the BFS industry

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1	Introduction : Role of banks, Payment Banks and NBFCs in credit supply to Indian businesses and consumers, Definition and Principles of Insurance	Lecture	To familiarise students with the importance of banking services and NBFCs
2	Types of customers and their accounts, KYC guidelines of the RBI, non-resident accounts, importance of customer service in banks - customer satisfaction and delight	Lecture and case discussions	To understand the role of customer service and satisfaction in the banking industry
3	Changing expectations and perceptions, features of modern banking – emerging trends in banking - e-banking , universal banking, m-banking, payment wallets	Lecture and case discussions	To understand trends in modern banking.
4	Banking products – Wholesale banking, Retail banking – personal/consumer loans, home loans, vehicle loans, educational loans, etc. International banking, bancassurance, credit cards, debit cards, other retail banking products.	Lecture and case discussions	To understand the various banking products
5	CRM in banking services: Loyalty programs, grievance redressal mechanisms, priority banking, technological aspects of banking.	Lecture and case discussions	To understand key aspects of customer loyalty

No	Content	Activity*	Learning Outcomes
6	Marketing of financial services: Special features, service marketing mix, channels for banking services, Role of DSA/DMA in marketing bank products.	Lecture and case discussions	To develop a better understanding of various Financial Services available in India.
7	Regulatory framework in Financial Services: Role of SEBI, RBI,AMFI, IRDA	Lecture and case discussions	Understanding of Compliance issues.
8	Risk Management: Nature of business risks, Types of business risks, Risk mitigation, Role of rating agencies such as CRISIL, CARE, etc.	Lecture and case discussions	Understanding the nature and management of business risks

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Books

1	Principles & Practices of Banking – IIBF, Macmillan.
2	Bhalla. V.K. – 'Management of Financial Services' – Anmol, New Delhi.
3	Elements of Banking and Insurance – Jyotsna Sethi, Nishwan Bhatia, PHI Learning.
4	Customer Service & Banking Codes and Standards – IIBF, Taxmann.

Assessment

Internal	40%
Semester-end	60%

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester IV

Sr. No.	Common subjects
1	Project Management (UA)

FINANCE SPECIALIZATION

	Sr. No.	Electives (Any 1)
Final Project (300 Marks)	1	Commercial Banking
	2	Business Analytics
	3	Venture Capital and Private Equity

SYSTEMS SPECIALIZATION

	Sr. No.	Electives (Any 1)
Final Project (300 Marks)	1	Strategic Information Technology Management
	2	System Applications and Case Study
	3	Managing Technology Business and IT Resource Management

HRM SPECIALIZATION

	Sr. No.	Electives (Any 1)
Final Project (300 Marks)	1	OD and Change Management
	2	Strategic HRM
	3	Management of Corporate Social Responsibility in organizations

OPERATIONS SPECIALIZATION

	Sr. No.	Electives (Any 1)
Final Project (300 Marks)	1	Operations Applications and Cases
	2	Strategic Sourcing in Supply Management
	3	Operations Outsourcing & Offshoring

Proposed Revision for MMS Syllabus wef AY 2016-17 (Batch 2016-18)

Semester IV

Sr. No.	Common subjects
1	Project Management (UA)

MARKETING SPECIALIZATION

	Sr. No.	Electives (Any 1)
Final Project (300 Marks)	1	Integrated Marketing Communications
	2	Business to Business Marketing
	3	International Marketing
	4	Trends in Marketing

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER IV (CBGS)
With effect from Academic year 2016-17

FINANCE

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Project Management (UA)	27	2	40 IA	60 UA	100	3	4
2	Final Project - 3 nos	-	-	-	-	-	-	
	General Management	-	-	-	-	100	-	4
	Functional Specialisation	-	-	-	-	100	-	4
	Social Relevance	-	-	-	-	100	-	4

1 ELECTIVES OUT OF 3								
1	Commercial Banking	27	2	40 IA	60 IA	100	3	4
2	Business Analytics	27	2	40 IA	60 IA	100	3	4
3	Venture Capital and Private Equity	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**20**

UA: University Assessment **IA: Internal Assessment**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER IV (CBGS)
With effect from Academic year 2016-17

SYSTEMS

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Project Management (UA)	27	2	40 IA	60 UA	100	3	4
2	Final Project - 3 nos	-	-	-	-	-	-	-
	General Management	-	-	-	-	100	-	4
	Functional Specialisation	-	-	-	-	100	-	4
	Social Relevance	-	-	-	-	100	-	4

1 ELECTIVES OUT OF 3								
1	Strategic Information Technology Management	27	2	40 IA	60 IA	100	3	4
2	System Applications and Case Study	27	2	40 IA	60 IA	100	3	4
3	Managing Technology Business and IT Resource Management	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**20**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER IV (CBGS)
With effect from Academic year 2016-17

HRM

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Project Management (UA)	27	2	40 IA	60 UA	100	3	4
2	Final Project - 3 nos	-	-	-	-	100	-	
	General Management	-	-	-	-	100	-	4
	Functional Specialisation	-	-	-	-	100	-	4
	Social Relevance	-	-	-	-	100	-	4

1 ELECTIVES OUT OF 3								
1	OD and Change Management	27	2	40 IA	60 IA	100	3	4
2	Strategic HRM	27	2	40 IA	60 IA	100	3	4
3	Management of Corporate Social Responsibility in organizations	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**20**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER IV (CBGS)
With effect from Academic year 2016-17

OPERATIONS

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Project Management (UA)	27	2	40 IA	60 UA	100	3	4
2	Final Project - 3 nos	-	-	-	-	100	-	
	General Management	-	-	-	-	100	-	4
	Functional Specialisation	-	-	-	-	100	-	4
	Social Relevance	-	-	-	-	100	-	4

1 ELECTIVES OUT OF 3								
1	Operations Applications and Cases	27	2	40 IA	60 IA	100	3	4
2	Strategic Sourcing in Supply Management	27	2	40 IA	60 IA	100	3	4
3	Operations Outsourcing & Offshoring	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**20**

UNIVERSITY OF MUMBAI, MUMBAI
Masters in Management Studies - SEMESTER IV (CBGS)
With effect from Academic year 2016-17

MRKETING

CORE								
Sr. No.	Subject	Teaching Hours		Assessment Pattern				
		No. of Sessions of 90 minutes	No. of Sessions of 90 minutes per week	Continuous Assessment	Semester End Examination	Total Marks	Duration of Theory Paper (In hours)	No of Credits
1	Project Management (UA)	27	2	40 IA	60 UA	100	3	4
2	Final Project - 3 nos	-	-	-	-	100	-	
	General Management	-	-	-	-	100	-	4
	Functional Specialisation	-	-	-	-	100	-	4
	Social Relevance	-	-	-	-	100	-	4

1 ELECTIVES OUT OF 3								
1	Integrated Marketing Communications	27	2	40 IA	60 IA	100	3	4
2	Business to Business Marketing	27	2	40 IA	60 IA	100	3	4
3	International Marketing	27	2	40 IA	60 IA	100	3	4
4	Trends in Marketing	27	2	40 IA	60 IA	100	3	4
Total No of Credits								**20**

Programme - Masters in Management Studies
Semester - IV
COMMON SUBJECT

Semester	**:**	**IV Core**			
Title of the Subject / Course	**:**	Project Management			
Course Code	**:**				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	To introduce students of Management to concepts of Project
2	To apply and evaluate success parameters of cost ,time and quality in project management
3	To apply various techniques as cpm/pert/earned value analysis and projected financial statements
4	To enable student to conceive an idea, evaluate it's feasibility and make it workable.

Prerequisites if any	Finance Management(Capital budgeting, cost of capital,sources of finance), Business Statistics, HRM, Operations Research
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Overview of Project Management: Concepts and attributes of Project, Project lifecycle and stake holders, Project Organization, WBS, Scope and priorities, Project Identification, Market feasibility with Moving Average and Exponential smoothing methods, Techno-economic feasibility, Government policy to location, legal aspects, Preparation of DPR	Numerical examples and lectures	6 hrs Introduce concepts of basics of project management, Evaluate new project proposals, prepare detailed project report.
2	Project Planning : Time and cost estimates with AON and AOA conventions, Budget estimates, Network analysis, Float analysis, crashing concepts	Numerical examples and lectures	9 hrs Understand network diagram, critical path, concepts of crashing network.
3	Project scheduling and Risk Management: Gantt chart, splitting and multitasking ,Risks in time estimates, PERT analysis	Numerical examples and lectures	6 hrs Define risks in project management, make resource charts, find probability of completion of project.

Sr. No.	Content	Activity	Learning outcomes
4	Project Organization : Role and responsibilities of Project Manager, Team development model, sources of conflicts, conflict resolution	Lectures	3 hrs understand organization structure, flow of authority and responsibility
5	Earned value analysis : 'S' curve, Cost and schedule performance indices using network, Revised estimates of cost and time	Numerical examples and lectures	3 hrs Understand concepts of earned value, prepare revised estimates of cost and time.
6	Financial analysis: Profitability analysis ,Using NPV, IRR, Payback and discounted Payback period, PI. Preparation of projected statements of Income-expenditure and balance-sheet	Numerical examples and lectures	6 hr Evaluate project Financially, make projected statements of proposal
7	Computer applications and Softwares for Project Management	Demonstration lectures	3 hr introduce student to different softwares.
8	Project Management Cases	cases, presentation	4 hr apply all above principles To cases, students Presentations.

Text books

1	Project Planning estimation and assessment by Prasanna Chandra
2	Project Management : The Managerial Process by Gray and Larson 3E Tata McGraw-Hill
3	Quantitative Techniques in Management by N D Vohra

Reference books

1	Project Management Managerial Emphasis by Meredith and Mantel

Assessment

Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - IV

FINANCE (ELECTIVES)

Semester	**:**	**IV – Elective**			
Title of the Subject / course	**:**	**Commercial Banking**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objective

1.	To understand the concepts and fundamentals of Commercial Banking,
2.	To understand the Structure and growth of banking and various services rendered through commercial banks.

Prerequisites if any	Financial Management and Financial Markets and Institutions, Investment Banking and BSFI.
Connections with Subjects in the current or future courses	

Module

Sr. No.	Content	Activity	Learning Outcome
1.	**Introduction to Commercial Banking** Banking structure, growth/history of Indian banking, banking sector reforms.	Lecture and discussion	Knowledge and understanding of the history of Indian banking, banking sector reforms and related areas
2.	**Banking Operations** Retail liabilities, retails assets, KYC, ALM and preventive vigilance.	Lecture and discussion	Understand basic schemes of deposit and credit, dangers of money laundering and usefulness of preventive vigilance
3.	**Banking products** Fund based and fee based, term loan/working capital, appraisal process.	Lecture and discussion	Understand types of credits - term loan and working capital and how to appraise a credit proposal
4.	**Legal Aspects of Banking** Negotiable Instrument Act, Banking Regulation Act and RBI circulars.	Lecture and discussion	To understand important banking laws
5.	**Rural Banking** India's agrarian sector and banking, regional rural banks, priority sector and micro-finance differentiated banks, financial inclusion.	Lecture and discussion	Understand measures taken towards financing priority sector schemes

Sr. No.	Content	Activity	Learning Outcome
6.	**Study of Bank financial statement** Components of Balance Sheet and Profit and Loss Statement, important ratios of bank performance- CAMEL framework, composition of items contributing to net profit.	Lecture and discussion	Understand how to evaluate a bank's performance
7.	**IRAC Norms / NPA Management** Reasons, impact on banking performance and economy, measures taken to minimize NPA.	Lecture and discussion	Understand intricacies of asset quality deterioration and impact on banks
8.	**Risk Management in Banks** Credit, market and operational risks.	Lecture and discussion	To know the various risks in banking operations and tools of management of risks
9.	**Capital Adequacy Norms** Importance of capital for banks, Basel I/II/III and CAR.	Lecture and discussion	To be aware of significance of capital adequacy regulation and impact on banks
10.	**Treasury** Role and functions of integrated treasury.	Lecture and discussion	Understand foreign exchange and money market operations.
11.	**Asset Liability Management** Interest spread, NIM.	Lecture and discussion	To understand importance of ALM and its impact on profitability
12.	**Regulatory Role of RBI** Functions of RBI, role of monetary policy, prudential norms.	Lecture and discussion	To know the role and functions of Central Banks in supervision and control of commercial banks
13.	**Retail banking products** Housing loan, personal loan, automobile loan, education loan.	Lecture and discussion	To understand various banking products of retail banks

Text Books

1	Indian Institute of Bank Management , Advanced Bank Management.
2	Vijayraghawan Iyengar, Introduction to Banking.
3	Raghu Palat , Retail Banking.

Reference books

1	Bharati V Pathak , The Indian Financial System.
2	Shri. S K Das, Tits Bits of General Banking.
3	Shri. S K Das , Tits Bits of General Advances and Financial Services.
4	Sukhvinder Mishra , Banking Law and Practice.
5	Indian Institute of Banking and Finance, Legal aspects of Banking Operations.

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**IV – Elective**			
Title of the Subject / course	**:**	**Business Analytics**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To gain understanding of relevant statistical tools applicable for Business Analytics.
2	To learn data mining techniques using Excel and R.
3	To evaluate various models of Business Analytics.

Prerequisites if any	Knowledge of Statistics and MS Excel
Connection with subjects in the current or Future courses	Financial Modelling

Module

Sr No	Content	Activity	Learning outcomes
1	**Introduction to Analytics** Meaning, application areas of business analytics, techniques of analytics.	Classroom discussion	Basic understanding of business analytics
2	**Statistics for Business Analytics** Central tendencies and dispersion, central, limit theorem, sampling distribution, hypothesis testing, simple linear regression, categorical data analysis, analysis of variance (ANOVA), non-parametric tests.	Discussion and practical using software	Ability to apply various statistical tools and techniques in the process of business analytics
3	**Advanced Excel Proficiency** Describing Numeric Data, Pivot Table Analysis, Linear Regression, Comparing Two Sample Variances, Comparing Two Sample Means, Pair T Test, One Way ANOVA, Two Way ANOVA, Generating Random Numbers, Rank and Percentile, Histogram Procedure, Exponential Smoothing and Moving Average, Sampling, Covariance and Correlation, Goal Seek and Solver.	Discussion and practical on MS excel	Use of advanced Excel functions
4	**Understanding R** Using R Studio, working with data in R, R procedures.	Discussion and practical cases on R	To understand use of R
5	**Data Mining using Decision Tree** Introduction to decision trees, model design and data audit, demo of decision tree development, algorithm behind decision tree and other decision tree.	Discussion and practical using software	Data mining techniques using R

Sr No	Content	Activity	Learning outcomes
6	**Data Mining using clustering in R** Understanding cluster analysis using R, clustering as strategy, hierarchical clustering, non-hierarchical clustering - K means clustering, variants of hierarchical clustering, different distance and linkage functions.	Discussion and practical using R software	Data mining techniques using R
7	**Time Series Forecasting** Time series vs causal models moving averages, exponential smoothing, trend, seasonality, cyclicity causal modelling using linear regression forecast accuracy.	Discussion and practical using software	Data mining techniques using R
8	**Predictive Modelling – Logistic Regression using R** Data import and sanity check, development and validation, important categorical variable selection, important numeric variable selection, indicator variable creation, stepwise regression, dealing with multicollinearity, logistic regression score and probability, KS calculation, coefficient stability check, iterate for final model.	Discussion and practical using R Software	Evaluation of models
9	**Overview of Big Data and Hadoop** Big data and Hadoop and concept, application, cloud computing, generators of big-data.	Classroom discussion	Understand tools of business analytics
10	**Data Analysis and Applications** Credit risk analytics, fraud risk analytics, financial services marketing analytics.	Classroom discussion	Ability to apply business analytic tools

Text Books

1	Laursen & Thorlund, Business analytics for managers.
2	Balram Krishnan , Business analytics: concepts and theories.
3	R N Prasad and Seema Acharya , Fundamentals of business analytics.

Reference Books

1	Thomas W Miller , Modelling techniques in predictive analytics
2	Lander ,R for everyone: advanced analytics and graphics
3	Evans ,Business analytics

Assessment

Internal	40 %
Semester end	60%

Semester	**:**	**IV – Elective**			
Title of the Subject / course	**:**	**Venture Capital and Private Equity**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	To develop general understanding of the venture capital and private equity industry globally and the various players involved.
2	Provide an understanding of the private equity investment process starting from fund raising to exiting.
3	Develop analytical valuation and deal structuring techniques used in venture capital and buyouts.
4	To prepare students for future jobs in VCPE and related industries.

Prerequisites if any	Financial Management
Connection with subjects in the current or Future courses	Project and Infra Finance, Mergers and Acquisitions and Investment Banking.

Module

Sr. No	Content	Activity	Learning outcomes
1	**Introduction and Overview of Venture Capital and Private Equity.** Overview and history of venture capital industry, evolution of private equity industry and venture capital industry, how to choose and approach a venture capitalist, structure and terms of venture capital and private equity firms.	Classroom discussions	Understanding of private equity process
2	**Process of Venture Capital and Private Equity Funding** Venture capital cycle and private equity process.	Classroom discussions and explanation	Understanding how corporates invest in a new private equity
3	**Investment Selection, Fund Raising Challenges** Sources of capital, alternative forms of fund raising and fundraising process and fallacies.	Numerical solving and classroom discussions	Awareness of the current investing patterns, problems and issues faced by industries and PE investors
4	**Valuation Methods and Techniques** Deal valuation and deal terms.	Numerical and classroom discussions	Understand financial valuation methods and strategies and the impact of dilution
5	**Structuring Term Sheets** Environmental factors surrounding term sheets, selected critical elements in venture term sheets.	Classroom discussions and explanation	Integrating the valuation with term sheet

Sr. No	Content	Activity	Learning outcomes
6	**Document and Typical Investment Conditions** Due diligence procedures.	Classroom discussion	Understanding documents and critical pointers to due diligence
7	**Exit Strategies for Multiple Stakeholders** Consider liquidity events such as IPO, mergers, later stage financing, including mezzanine financing and buy-outs.	Classroom discussion and explanation	Understanding strategies made to negotiate and exit the fund
8	**Regulation of PE Funds** SEBI Alternative Investment Funds (AIF) Regulations.	Classroom discussion and explanation	Understanding PE funds regulation
9	**Tax Aspect of PE Investment** Section 10(23FB) of Income Tax Act, 1961 Section 10(47) of Income Tax Act, 1961 Income types, Securities Transaction Tax, Dividend Distribution Tax, STCG, LTCG, Taxation of Non Residents.	Classroom discussion and explanation	Overview of taxation aspects while choosing PE as an investment alternative
10	**Private Equity Investments in Developing Markets**	Classroom discussion	To know the trends of the PE funding in the developing economies
11	**Private Equity, Corporate Governance and Ethics** Board members duty to shareholders, composition and roles of the board of directors in the private company.	Classroom discussion	Importance of ethics and value system

Text Book

1	T Satyanarayan Chary , Venture Capital concepts & Applications
2	Vandana Pawar , Venture Capital Funding Global And Indian Experiences.
3	Stephen Bloomfield , Venture Capital Funding

Reference Book

1	Josh Lerner, Felda Hardymon and Ann Leamon, Venture Capital and Private Equity: A Casebook.
2	Robert Finkel , The Masters of Private Equity and Venture Capital.
3	Joseph. W. Bartlett , Fundamentals of Venture Capital

Assessment

Internal	40 %
Semester end	60%

Programme - Masters in Management Studies

Semester - IV

SYSTEM (ELECTIVES)

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Strategic Information Technology Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the strategic use of Information Technology for Competitive Advantage
2	To understand Emerging trends of information technology to devise organization /business strategy

Prerequisites if any	Basic understanding of Strategic Information Technology Management
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Role of Information systems in organization, Some key concepts related to strategy such as value chain, five forces, information asymmetry, emerging trends in IT to devise organization /business strategy

Module

Sr. No.	Content	Activity	Learning outcomes
1	Information Technology and Competitive Advantage– • Role of Information systems in organization, Some key concepts related to strategy such as value chain, five forces, information asymmetry and Technology Investment • Information Technology vs. Information systems • Two different approaches for gaining Competitive Advantages-Market Based Approach and Resource Based Approach • Strategic Role of IT in gaining Competitive Advantages	Lecture	Understand Role of Information Systems in Business Activities and Strategic Role of IT in gaining competitive advantage
2	ERP systems, Business Processes and IT • Meaning and definition, introduction of Business Process, Organizational processes and Information systems • Use of ERP in Business Process • Business Process Reengineering,	Lecture & cases	Basic Understanding of Enterprise systems
3	Using Information for Decision Making • How organization leverage data/information for competitive advantage • Importance of database, data warehouse, Data mining , and Business Intelligence, How they can be used as part of an organization strategy for Competitive Advantage	Lecture	Understanding the importance of Decision Making using Data Mining & BI Tools

Sr. No.	Content	Activity	Learning outcomes
4	Research on Internet use • Marketing Online- Online Advertising, Social Media and digital Marketing	Lecture and cases	Understand the Web Based Research Tools
5	Technology Trends Emerging trends of information technology to device business strategic, • Web related technologies, web media, how to use world wide web for business and marketing purpose • Mobile technology impact of mobile technologies on business and mobile strategy for a business	Lecture and cases	Grasping with the latest trends in Strategic IT Domain
6	Creating a Technology Strategy • Developing an IT Strategy • Writing your own strategy- Develop your web, web media and mobile strategy	Lecture & Cases	Learning the process of developing IT Strategy and creating new strategies for web and mobile development
7	Case Studies and presentations	Group Discussion & Workshop	

Text books	
1	Strategic Management of Information Systems by Keri Pearlson and Carol Saunders
2	Strategic Management Of Technology & Innovation by Robert Burgelman, Clayton Christensen, Steven Wheelwright
3	Strategic Technology Management by Betz
4	IT Strategy & Management by Sanjiva Dubey
5	The Strategic Management of Information Systems by Joe Peppard & John Ward

Reference books	
1	Strategic Management and Information Systems: An Integrated Approach by Wendy Robson
2	A Guide to Expert Systems by Donald Waterman
3	Strategic Information Systems Management by Kevin Grant
4	Work-study by ILO
5	Leading Digital - Turning technology into Business Transformation by HBR

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**System Applications and Case Study**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Importance , scope and need of case study and applications areas of information technology/information system for business
2	To have the practical applications areas of information technology &Information System across the various functions and sectors of the industry

Prerequisites if any	Basic understanding of System Applications and Case Study
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Importance , scope and need of case study and applications areas of information technology and Information systems for business

Module

S No	**Content**	**Activity**	**Learning outcomes**
1	Importance, scope and need of case study and applications areas of information technology and information systems for business.	Lecture	Understanding the scope and need of IT in Business
2	Applications areas of information technology & information System across the various functions of management i.e. Marketing, Finance, Human Resource, Manufacturing and Operations, Supply Chain Management, Logistic, Customer Relationship Management and also as per various different functions of the organizations	Lecture & cases	Knowing the applications of IT in Various business functions
3	Applications areas of information technology & Information System across the various sectors of the industry. Manufacturing Pharmaceuticals and Fine Chemicals Chemicals & Petro - chemicals FMCG – home appliances, Food processing, Dairy and dairy products Mills - paper, pulp, board, textile, Leather - Tanning of leather to making of finished goods, Agricultural Products – grains, jute, cotton, oil seeds, plantation of vegetables, fruits, Heavy industries - automobiles, aircraft, ship building & maintenance, cranes, Constructions – bridges, dams, roads,	Lecture	Understanding the IT applications across various industry sectors Understanding the IT applications across various industry sectors

S No	Content	Activity	Learning outcomes
	Power industries – thermal, nuclear, hydro power stations, Merchandising, stockiest, Trading, etc. Insurance, Banking and Finance, Service industry – Hospitals, hotels, Travel and Tourism, transport, Film – manufacturing, distribution, production units, laboratories, editing, exhibitors, Gem & Jewelry – Import of raw export of finished diamond, artificial diamonds, gems and stones,		
4	Government - Ministries, Departments like defense, police, RTO, passport, visa, customs, central excise, railways, and the IT industry	Lecture and cases	Understand the Role of IT in Govt. related areas like Passport, RTO etc.
5	Case study and presentations of information technology and Information system across the function and sectors of industries	Individual Assignments and Discussions	

Text books	
1	System Analysis & Design by Dennis and Roth published by Wiley
2	Analysis and Design of Information Systems by Rajaraman published by PHI
3	Analysis and Design of Information Systems by Senn published by TMH
4	Information Technology: Best Practices and Applications in Business by T.A.Adikesavan
5	Information Technology in Business : Principles, Practice and Opportunities by J.A.Senn

Reference books	
1	System Analysis and Design by Kendall and Kendall published by Pearson
2	System Analysis & Design by Whitten & Bentley
3	Marketing Management and Information Technology by Fletcher
4	Supply Chain Information technology by David Olson
5	Handbook of Information technology in Finance by Paoli, Holtmann, Stathel & Jakobi

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**III Elective**			
Title of the Subject / course	**:**	**Managing Technology Business & IT Resource Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the Need and Significance of IT resource management
2	Understand applications of Determining IT and Information System's Resource Needs and Business
3	IT &Information Systems resources Implementation and Acceptance
Prerequisites if any	Basic understanding of IT Resource Management
Connections with Subjects in the current or Future courses	Will connect conceptual framework to Need and Significance of IT resource management & Business

Module

S No	Content	Activity	Learning outcomes
1	Overview of the IT/ITES/Telecom and related businesses in India and the world – segments of these industries , growth, forecasts, trends, key players, reasons for their success etc.	Lecture	Understanding the overview of IT/ITES Industry
2	Challenges for businesses in the domestic and international markets such as Business Development, Technology Obsolescence, Pricing, Set up & Infrastructure Costs, Talent management , Licensing costs & Intellectual property rights, Mergers and Acquisitions , Customer Contract Management and SLAs , managing Innovation , legal issues, Visa's, Foreign Soil issues, Special Incentives and schemes such as the Export Processing Zones etc.	Lecture & cases and class research	Gaining an insight on the challenges in implementing IT based Systems
3	Study of various business models including onsite/off shoring, e-commerce, e-business, m – commerce and pure play 'e' and 'm' models.	Lecture	Getting acquainted with Business Models
4	Introduction to IT and Information System Resource Management Evolution of IT and Information System Resource Management (Software, Hardware, Database, Networking, and communications technology, human	Lecture and cases	Understanding the Concept of IT Resource Management

S No	Content	Activity	Learning outcomes
	resource etc) for Planning and Implementation of information technology and technology base system across the functions and sectors of the industries.		
5	Determining IT and Information System's Resource Needs: Needs Analysis, planning ,System Cost Justifying and Investments, Automation and Artificial Intelligence	Lectures, Research and Cases	Gaining insight on the need, investments and Implementation of IT Resources in an Organization
6	Effective use of IT & Information Systems resources Implementation and Acceptance, maintenance for productivity	Lectures	Effective usage of IT systems can be gained
7	IT & Information Systems Resource its relevance to Human resource management & Business, Outsourcing challenges of Internal Functions – the what, Why and How	Lectures, Research and Cases	Relevance of IT, HRM & Outsourced Business Functions can be well understood
8	Case Studies of successful and unsuccessful technology companies	Group and Individual assignments	

Text books	
1	Managing the IT Resource: Leadership in the Information Age by Luftman published by Pearson
2	Technology Roadmapping for Strategy and Innovation by Moehrle, Isenmann & Phaal
3	Management of Technology by Khalil
4	IT Infrastructure and Its Management by Gupta, Prakash and Jayaraman
5	Business Information Management by Benson and Davis

Reference books	
1	Managing IT Infrastructure – TMI
2	A Guide to PMBoK- Project Management Institute
3	Managing Information Technology Resources by Dr.Jerry Luftman
4	Work-study by ILO

Assessment	
Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - IV

HRM (ELECTIVES)

Semester	**:**	**IV – Elective**			
Title of the Subject / course	**:**	**OD and Change Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives

1	Basics of Change Management
2	Understanding OD Approaches and Models
3	Understanding Organizational Development – Diagnostics
4	Different Strategies, Approaches and Models
5	Trends in OD and Change Management

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	Process of Change – The Process of Change, Creativity & Innovation: Organizational Change. Definition & Key Dimensions, Factors that Promote Change, Creativity & Innovation, Theories of Innovation and Levels & Types of Innovation, The age of Creativity, Creativity & National prosperity, Creative Industries & potential for growth	Case Study/ Role-play/ Group Discussion	Understand the process of change in detail
2	The Internal Environment – Orchestrating Structure, Systems and Resources; The Balanced Score Card – Value Creation and Performance management. Organizational Structure – work specifications, departmentalization, chain of command, span of control, centralization and decentralization, Formalization. Situational factors– Corporate Strategy, Organizational Size and Environmental uncertainty.	Case Study/ Role-play/ Group Discussion	Impact of change on internal environment and management of the internal environment to make it conducive to change

	Structural forms – Traditional and contemporary forms. Organizing for change, creativity and innovation - Goal Setting and reward Systems. Evaluation. Resources – Sufficient resourcing. Systems of Communication.		
3	Organizational culture, Different Perspectives of Organizational culture, Can we manage Organizational culture? Culture as an important ingredient of Organizational Creativity. Norms that promote Creativity and Innovation, Norms that promote Implementation. Principles of creativity and innovation. Do strong, cohesive cultures hinder innovation?	Case Study/ Role-play/ Drama/ Group Discussion	Understanding the role of organizational culture and its impact on change management
4	Definitions, underlying assumptions and values of Organization Development	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to the concept of OD
5	Approaches to OD - Systems Approach, Action Research	Case Study/ Role-play/ Drama/ Group Discussion	Study of different approaches to OD
6	Organization Diagnosis & Diagnostic Data Collection & Analysis including Climate Understanding Organizational Roles □ OD Intervention theories and methods – □ Large Systems, □ Group and □ Individual Techniques	Case Study/ Role-play/ Drama/ Group Discussion	Understanding diagnosis, different diagnostic models and methods of data collection and analysis Study of different types of OD interventions
7	Monitoring Change in Organizations Fundamentals of monitoring change, steps of measuring change, methodologies for measuring change	Case Study/ Role-play/ Drama/ Group Discussion	Introduction to methods of monitoring change
8	Latest trends in OD and Change Management	Case Study/ Role-play/ Drama/ Group Discussion	Study of latest trends in OD and change management
9	Case studies and Presentations		

Text Books

1	Cummings, Thomas G, Worley, Christopher G. Essentials of Organizational Development and Change
2	Organisational Change and Development – Dipak Kumar Bhattacharya – Oxford Publications

Reference Books

1	Organizational Development – French & Bell
2	Change Management by Andrew Pettigrew and Richard Whipp Infinity Books

Assessment

Internal	40%
Semester end	60%

Semester	:	**IV-Elective**			
Title of the Subject / course	:	**Strategic HRM with Global Perspective**			
Course Code	:				
Credits	**:**		**Duration in Hrs.**	**:**	

Learning Objectives

1	To learn the basics of HR strategy formulation and implementation in domestic as well as international scenario, talent management and competency based HRM

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

S. No.	Content	Activity	Learning Outcome
1	**Strategic Human Resource Management** Introduction, Strategic HRM- Definition , Aims, Approaches, Challenges. Role of HR as a Strategic Partner in an Organisation	Case Study/Role Play/Group Discussions	Learning the basics of Strategic HRM
2	**HR Strategies:** Definition, Types of HR Strategies, Criteria for an Effective HR Strategy, Formulation of HR Strategies, Conducting a Strategic Review, Implementing HR Strategies Impact on Organizational Performance, Strategic role of Top Management, Strategic role of Line Management	Case Study/Role Play/Group Discussions	Introduction to HR strategies
3	**Talent Management** Career Planning and Succession Planning: Evolution of Careers, Career Planning Perspectives Organization-Centered Career Planning, Individual- Centered Career Planning Succession Planning: Definition and Approaches, Elements of Succession Planning, Relationship between Career Planning and Succession Planning, Challenges of Succession Planning, Global Practices in Career and Succession Planning	Case Study/Role Play/Group Discussions	Introduction to talent management

S. No.	Content	Activity	Learning Outcome
4	**Competency and Potential Development:** Competencies defined and types of Competencies, Difference between Competency and Potential, Potential Development, Difference of Competencies from Skills and Knowledge, Integrated HR Practices through Competency Development, Benefits from Competency-Based HR Practices, Outcomes for Employees'Development, Developing a Skill Matrix, Retention Strategies	Case Study/Role Play/Group Discussions	Learning basics of competencies and competency based HR practices
5	**Strategies for Improving Organizational Effectiveness** Strategies for improving Organizational Effectiveness Strategies of Organizational Transformations-Cross border HR issues in Mergers & Acquisitions and the role of HR Strategies for Culture Management, Strategies for Developing Learning Organizations Employee Engagement Strategies	Case Study/Role Play/Group Discussions	Learning Strategies for Improving Organizational Effectiveness
6	**Global Dimensions of HR Strategies** HR Strategies in International Context, converting Global Presence into Global Competitive Advantage Selection & Staffing of International Employees Developing Cross Cultural Sensitivity Training & Development of International Staff Compensation Approaches & Issues Performance Management in International Organizations International Industrial Relations, Legislation and the international workforce, International Labor Standards Expatriation & Repatriation Emerging Trends in International Labor Markets	Case Study/Role Play/Group Discussions	Introduction to HR strategies in international context
7	Case Studies and Presentations.	Case Study/Role Play/Group Discussions	

Text books

1	Strategic Human Resource Management by Jeffrey Mello, Thomson South Western

Reference books

1	Strategic Human Resource Management by tanuja Agarwala,Oxford Publications
2	International Human Resource Management by Peter j Dowling, Device Welch, 4th Edition.

Assessment

Internal	40%
Semester end	60%

Semester	:	**IV-Elective**			
Title of the Subject / course	:	**Management of Corporate Social Responsibility in organizations**			
Course Code	:				
Credits	**:**	**4**	**Duration in Hrs.**	**:**	**40**

Learning Objectives

1	According to Companies Act, 2013, at least 2% of a company's average net profit of immediately preceding three financial years has to be spent on CSR activity. However, this expense is subject to compliances of the guidelines prescribed under company law. CSR professionals with sound knowledge only can help companies benefit from the expenditure and provide a detailed analysis of spending and the impact it is creating on the targeted beneficiary as well as the bottom line of the company. **This course work will enable professionals to manage and drive CSR in their respective organizations.**

Prerequisites if any	
Connections with Subjects in the current or Future courses	Corporate Social Responsibility – Semester II

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Definitions, Concepts and International Frameworks of CSR** Definitions and meanings of Corporate Social Responsibility, Business at the bottom of the pyramid, International frameworks of CSR	Case Study/Role Play/Group Discussions	Basic Concepts of CSR and its relevance to the organization
2	**History and evolution of CSR (International and Indian)** History and evolution of CSR (International Generic) History and Evolution of CSR (Indian History - Detailed) – from philanthropy to public-private-people partnerships Evolution of Indian CSR framework (Pre Companies Act 2013)	Case Study/Role Play/Group Discussions	History and evolution of CSR in the international arena as well as Indian context
3	**Issues in Indian Economy and Social Development |**	Case Study/Role Play/Group	Knowledge about key economic and social

Sr. No.	Content	Activity	Learning outcomes
	Government Expectations, Roles and Responsibilities Issues of poverty, unemployment, unskilled labour, sanitation, immigration to urban areas and economic and social divide. Key international CSR initiatives of governmental or intergovernmental bodies	Discussions	issues in India Introductory knowledge about CSR initiatives by govt. and NGOs
4	**CSR and Companies Act 2013** Detailed reading, analysis and interpretation of Section 135 and Schedule VII of the Companies Act 2013 as well as the provisions of the Companies (Corporate Social Responsibility Policy) Rules, 2014	Case Study/Role Play/Group Discussions	Detailed knowledge about provisions for CSR in the Companies Act 2013
5	**Preparation of CSR Policy | Process of Policy Formulation** Constitution of CSR committee as per legal guidelines | Conducting CSR Assessment | Preparing CSR strategy framework| Tools, technical guidance and standards to be used for policy formulation | Determining the implementation mechanism	Case Study/Role Play/Group Discussions	Introduction to the process of CSR policy preparation
6	**Implementation of CSR Policy | Project and Programme Mode** Operationalizing the institutional mechanism | Different modes of implementing the CSR strategy | Decision making criteria |Due diligence of implementation partner | Project development and approval | Finalizing the arrangement with the implementation agency	Case Study/Role Play/Group Discussions	Detailed knowledge of methods of implementation of CSR Policy
7	**Monitoring Mechanism and Tools | Social Impact Assessment | Evaluation (Concurrent and Final Evaluation)** Determining mid-course corrections | Recommendations for future project designs | Identifying methods for conducting the impact assessment | Identifying the skills set required for the impact measurement team | Tools, technical guidance and standards to	Case Study/Role Play/Group Discussions	Introduction to various tools for monitoring and evaluation of CSR programmes

Sr. No.	Content	Activity	Learning outcomes
	be used (London Benchmarking Group(LBG) model • Social return on investments (SROI), The SROI network • Global impact investing network (GIIN) • Accountability -: AA 1000, Institute of Social and Ethical Accountability • ISO 26000: social responsibility • Public consultation guidelines of Government of India)		
8	**CSR Audit** The inclusion of all significant stakeholder groups in the auditing process | Diversity in individual perceptions of CSR | The shortcomings of the 'tick-box' approach to auditing CSR | Development of CSR Stakeholder matrix	Case Study/Role Play/Group Discussions	Detailed knowledge of conducting a CSR Audit
9	**Reporting Framework** Importance of reporting | G3 guidelines for CSR | SEBI directive on ESG disclosure (if applicable) | RBI guidelines on CSR, sustainable development and nonfinancial reporting	Case Study/Role Play/Group Discussions	Detailed knowledge of preparing CSR reports
10	**Brand Building and Corporate Image** Brand differentiation | Corporate Reputation | Corporate Social Marketing |Branding as a tool for CSR	Case Study/Role Play/Group Discussions	Introduction to branding and using it as a tool to promote CSR
11	**Role of Civil Society | Role of Social Entrepreneurs | Role of Supply Chain | Role of banking/Investors**	Case Study/Role Play/Group Discussions	Introduction to role of citizens, banks etc. in the implementation of CSR
12	**Corporate Governance and CSR** Definition of Corporate Governance | Scope and benefits | Principles of Corporate Governance | Governance Metrics International (GMI) | World Bank and G7 Response | Government as Shareholder: The Institutional Investor as Proxy for the Public Interest	Case Study/Role Play/Group Discussions	Introduction to Corporate governance
13	**Sustainable Development** Concept of sustainable	Case Study/Role Play/Group	Introduction to sustainability and

Sr. No.	Content	Activity	Learning outcomes
	development | Preparing Sustainability Report	Discussions	preparation of sustainability report

Text books

1	Corporate Social Responsibility: Concepts and Cases : the Indian Experience By C. V. Baxi, Ajit Prasad
2	Handbook of Corporate Social Responsibility in India: PWC and CII

Reference books

1	Key Concepts in Corporate Social Responsibility By Suzanne Benn, Dianne Bolton – Sage Publications
2	Corporate Social Responsibility, Entrepreneurship, and Innovation By Kenneth Amaeshi, Paul Nnodim, Osuji Onyeka - Routledge
3	Corporate Social Responsibility and Sustainable Development in Emerging ... edited by Dhirendra K. Vajpeyi, Roopinder Oberoi – Lexington Books
4	Empowering Organizations through Corporate Social Responsibility edited by Wolf, Ruth, Thoedora Issa and monica Thiel – IGI Global
5	Corporate Governance, 5th Edition By Robert A. G. Monks, Nell Minow - Wiley
6	Corporate Social Responsibility An Implementation Guide for Business By Paul Hohnen – International Institute for Sustainable Development
7	Corporate social responsibility Audit: from theory to practice By R Morimoto, J Ash & C Hope – University of Cambridge

Assessment

Internal	40%
Semester end	60%

Programme - Masters in Management Studies

Semester - IV

OPERATIONS (ELECTIVES)

Semester	**:**	**III Electives**			
Title of the Subject / course	**:**	**Operations Applications and Cases**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To enable a student to understand the complex processes and operations of product & service industry
2	To apply various techniques, tools & practices in different situations to design & execute system in best manner
3	To develop a model as an extension from academic to practical complex real life situation.

Prerequisites if any	Statistics for Management, Operations Management, Operations Research, Cost & Management accounting, Financial Management
Connections with Subjects in the current or Future courses	Project Management

Module

	Content	Activity	Learning outcomes
1	Application of Operations Management in Complex situations, Resource planning, Process analysis review	Lecture, examples on Spread sheet, cases	Apply basic principles of Operations Management & understand resource limitations and its impact
2	Applications in production & retail sector, practical examples of MRP-I & II on Excel	Lecture, examples on Spread sheet, cases	To understand material planning in Retail sector
3	Applications related with workforce, examples of aggregate planning on Excel	Lecture, examples on Spread sheet, cases	To understand labour force planning and its nuances
4	Applications related with plant, investment, replacement &maintenance, Robotic process and financial evaluation, optimum period of replacement on excel	Lecture, examples on Spread sheet, cases	To understand problems of plant maintenance and parts replacement, find ideal period of replacement
5	Application of learning in tendering &bidding, cost aspects, examples on excel	Lecture, examples on Spread sheet, cases	Find impact of learning on cost of delivery in bidding
6	Uses in insurance, BPO/KPO, entertainment, production, etc.	Lecture, examples on Spread sheet, cases	To apply principles in sectors like insurance etc.

Text Book	
Operations Management	Chase Aquilano, Jacobs
Operations and Supply Chain Management	F. Robert Jacobs, Richard Chase

Reference books	
Production and Operations Management	Norman Gaither
Operations Management: An Integrated Approach:	Danny Samson, Prakash J. Singh

Assessment	
Internal	40%
Semester end	60%

Semester	**:**	**IV Electives**			
Title of the Subject / course	**:**	**Strategic Sourcing in Supply Management**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	Introduce various parameters required to develop and implement a procurement strategy that aligns with the overall competitive strategy of the organization.
2	Provide knowledge to understand how Strategic sourcing enhances efficiency and value, ultimately impacting the profitability of the entire organization.
3	Familiarize with concepts of ethical and contractual risk management, sustainability, and legal issues faced by purchasing and supply chain managers.

Prerequisites if any	Materials Management
Connections with Subjects in the current or Future courses	

Module

Sr. No.	Content	Activity	Learning outcomes
1	**Introduction to purchasing and supply chain management** A new competitive environment, Why Purchasing Important. Purchasing and supply Management, Supply chains and value chains Enablers of purchase ad supply chain management Evolution of Purchasing and supply management.	Lecture and discussion.	Basic understanding of Purchasing
2	**Purchasing and supply process** Objectives –Supply continuity, Sourcing process efficiency and effectiveness Develop Supply base management, Develop aligned goals with internal stake holders Developing purchasing strategies that support organizational goals and objectives.	Lecture and discussion.	Development of Basic purchasing strategies
3	**Strategic Supply Management- Roles and Responsibilities** Spend analysis, Demand management and specifications / SOW's Category Management and supplier evaluation / selection Contract Management(Purchase and Service), Cost Management, Managing the procure to pay process Supplier relationship Management.	Lecture and discussion.	Understanding about pattern of spending and costing

Sr. No.	Content	Activity	Learning outcomes
4	**Improving Procure to pay process** Forecast and plan requirement, Needs clarification, Purchase requisitioning of work. Travelling purchase requisitions / Bar codes, Forecast and customer orders. Reorder point system, Stock checks, Cross functional sourcing teams. Supplier identification and selection,Bidding or Negotiations, Request for quotations. Specifications or Blueprints, Evaluate Suppliers.	Lecture and discussion.	Understanding of purchase cycle from requisition to payment
	International procurement-Imports. a) International commercial terms. b) Import procedures and documentation. c) Categories of importers. d) Identification of foreign sources. e) Payment terms including Letter of credit. f) Types of L/Cs. g) Custom tariff h) Custom clearance. i) Bill of Lading and other documents	Lecture with display of relevant documents	Basic introduction to imports
5	**Purchase order preparation** Purchase order, Blanket purchase order, and Material purchase release Receipt and inspection, Material packing slip, Bill of Lading Receiving Discrepancy report, Invoice settlement and payment Record Maintenance, Continuously measure and Manage supplier performance Reengineering the procure to pay process	Lecture and discussion.	Understanding of types of purchase orders
6	**Types of Purchases** Raw material, Semi finished goods, components, support items, Services, and Capital equipment. Transportation and third-party purchasing, Online requisitioning systems. Procurement cards issued to users, Electronic purchasing commerce through internet Long term purchase agreements, Online ordering system to suppliers Purchasing process redesign, Online ordering through electronic catalogue.	Lecture and discussion.	Understanding about classification about various types of items.
7	**Purchasing and Supply chain Organization** Organization structure, Location of authority, Centralized or Decentralized structure, Drivers, advantages of Centralized or Decentralized structure.	Lecture and discussion.	Understanding of organization stricture and link between purchase and supply chain function.

Sr. No.	Content	Activity	Learning outcomes
	Reporting of Purchasing positions and Factors affecting Purchasing position. Scope and Job Tasks of Purchasing / Supply Management Report. Separating Strategic and Operational Purchasing.		
8	**Supplier Evaluation and Selection** Identify Potential Supply Sources, Use of preferred Suppliers. Key supplier evolution Criteria. Developing a Supplier Evaluation and Selection Survey, Tools and approaches.	Lecture and discussion.	Understanding of Supplier evolution and selection.
9	**Purchasing Analysis: Tools and Techniques** Project management, Learning Curve Analysis, Value Analysis/Value Engineering. Quantity Discount Analysis, Process Mapping	Lecture and discussion.	Understanding of Tools used in Purchasing.
10	**Worldwide Sourcing** Overview, Why source Worldwide, Barriers to Worldwide sourcing Developing worldwide sourcing programme. Cost associated with international purchasing, Managing Currency Risks.	Lecture and discussion.	Understanding of worldwide sourcing with currency impact.
11	**Strategic Cost Management** A structured Approach to cost Reduction. Price Analysis, Cost analysis techniques Total cost ownership, Collaborative Approaches to cost management.	Lecture and discussion.	Understanding of costing and reduction of cost.
12	**Negotiation** The Negotiation Framework in supply Management, Negotiation Planning. Power in Negotiation, Negotiation Tactics, Win-Win Negotiation. International negotiation, The Impact of Electronic Media on Negotiation	Lecture and discussion.	Understanding Negotiation
13	**Legal aspects and Ethics in purchasing** Legal authority and personal liability of the purchasing manager Contract Law, The uniform commercial code, Patents and Intellectual property Antitrust and unfair trade practice laws, Laws affecting Global purchasing	Lecture and discussion.	Understanding ethics in PURCHASING.

Text books		
1	Sourcing and Supply chain Management	Handfield , Monczka , Giunipero , Patterson
2	Procurement Principles and Management	Peter Baily, David Farmer, Barry Crocker, David Jessop, and David Jones
3	Strategic Sourcing	V V Sople
Reference books		
1	Procurement Principles and Management	Peter Baily, David Farmer, Barry Crocker
2	Strategic Procurement	Caroline Booth
Assessment		
Internal	40%	
Semester end	60%	

Semester	**:**	**IV Electives**			
Title of the Subject / course	**:**	**Operations Outsourcing and Offshoring**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning Objectives	
1	To understand the size & extent of Outsourcing & Offshoring
2	To know the risks & benefits of Outsourcing & Offshoring
3	To understand the decision making process for Outsourcing & Offshoring
4	Financial Evaluations for the Outsourcing & Offshoring
5	Non-financial Evaluations for the Outsourcing & Offshoring

Prerequisites if any	Operations Management, Service Operations Management
Connections with Subjects in the current or Future courses	Project Management

Module

	Content	**Activity**	**Learning outcomes**
1	Outsourcing a) Introduction b) Concept c) Goals and Objectives d) Sourcing , Outsourcing versus subcontracting e) Capacity, capability	Lecture with discussion	Understanding Outsourcing concept
2	Importance of Outsourcing a) Cost b) Benefits c) Challenges	Lecture with discussion on examples	Understanding Importance to the Organization
3	Factors driving Outsourcing a) Scale of production or service b) In house productivity c) Core/non core activities d) Efficiency e) Technology f) Lack of expertise g) Frequency of activity h) Environment i) Financial Analysis j) Non-Financial Analysis	Discussion with examples& numerical problems	Learning about important factors in Outsourcing
4	Implementation of Outsourcing a) Cost Analysis b) Negotiation c) Contract d) Network analysis for implementation e) Execution of activities	Lecture with examples & numerical problems	How to implement Outsourcing

	Content	Activity	Learning outcomes
5	Outsourcing Benefits a) Cost b) Capital Investment c) Manpower d) Access to Expertise e) Economies of scale f) Technology g) Quality h) Pooling effect of variability	Lecture with numerical examples & discussion	Understanding of financial as well as non-financial benefits
6	Outsourcing Challenges a) Contract risk b) Outsource Firm Risk c) Pricing risk d) Risk of creating Competitors e) Information Privacy Risk f) Firm Specific Risk g) Organizational Identity risk	Lecture with discussion	Risks pertaining to Outsourcing & mitigation of those risks
7	Offshoring a) Definition b) Concept c) Importance for India	Lecture	Basic understanding of Offshoring with respect to India
8	Activities Offshored a) Professional Judgement b) Communication Oriented c) Back-office transaction Process d) Manufacturing e) Services	Lecture with discussion	Learning about processes which are normally offshored to India
9	Quantification of Offshoring a) India specific b) Opportunities	Lecture	Financial impact for organization as well as for India
10	Offshoring Cost Issues a) Employees b) Transportation c) Perks d) Security e) Utilities f) Training expenses g) Tax rates h) Communication expenses	Lecture with discussion	Learning about costs related to Offshoring
11	Offshoring Non Cost Issues a) Quality b) Job status c) Productivity d) Response time e) Communication f) Knowledge g) Cultural bias h) Distance	Lecture with discussion	Learning about non-cost issues of Offshoring

	Content	Activity	Learning outcomes
12	Ethics of Offshoring a) Profitability b) Exploitation c) Employment d) Political relationship e) Trade disputes f) International disputes	Lecture with discussion	Ethical issues facing the Offshoring
13	Implementation of Offshoring Operations a) Change of working style b) Change of priority c) Capital intensive	Lecture with discussion	Issues related to implementation

Text books		
1	The handbook of Global Outsourcing & Offshoring	Ilan Oshri, Julia Kotlarsky
2		
3		

Reference books		
1	Multinational Firms in the World Economy	Barba Navaretti, G. and A. J. Venables
2	Successful Service Operations Management	Metters, King-Metters, Pullman and Walton

Assessment	
Internal	40% or 25 %
Semester end	60% or 75 %

Programme - Masters in Management Studies

Semester - IV

MARKETING (ELECTIVES)

Semester	**:**	**IV-Elective**			
Title of the Subject / course	**:**	**Integrated Marketing Communications**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

To understand how key elements of IMC i.e. Advertising, Public Relations, Sales Promotion, Direct Marketing are integrated.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No.	Content	Activity*	Learning Outcome
1	Definition of IMC, Key Features, Types.	Lecture	Understanding Basics of IMC
2	Advertising-Types of Media - TV, Print, Radio, OOH, Internet	Lecture	Understanding different Media for Advertising
3	Advertising- Developing the Campaign, effect of Celebrity endorsements. Advertising Agency- Functions, Types, Structure	Lecture / Industry Guest Lecture	To understand the working of an Ad-Agency
4	Reputation Management-Issues and challenges.	Lecture / Case study discussions	To learn how to manage perceptions during crisis
5	Promotional campaigns : Sales Promotion- Consumer Promotions, Trade Promotions etc.	Lecture / Case study discussions / videos	To learn the dynamics of various promotions
6	Direct Marketing-Methods, Advantages, Limitations	Lecture / Case study discussions	To understand direct marketing tools and techniques.
7	Media Planning- Media and Message, Media Planning Process, Media Objectives, Media Scheduling, Media Planning Implementation	Lecture / Case study discussions	To understand the various issues of media planning.

No.	Content	Activity*	Learning Outcome
8	Personal Selling- Principles, Negotiation Skills. Public relations, Internet Marketing-Email Advertising, Mobile Marketing, Search Engine Advertising, Social Media Marketing	Lecture / Case study discussions	To familiarize the different aspects of direct selling in person and through internet

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable

Recommended Book

1	Advertising and Promotion by George Belch, Michael Belch, Keyoor Purani, 9th Edition, McGraw Hill
2	Integrated Marketing Communication in Advertising and Promotion by Terence Shimp,8th Edition, Cengage Learning
3	Advertising and Promotion by Jaishree Jethwaney & Shruti Jain, 2nd Edition, Oxford

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**IV-Elective**			
Title of the Subject / course	**:**	**Business to Business Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

To develop an understanding of key aspects of B2B Marketing and manage marketing programmes for B2B markets.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

S. No	Content	Activity*	Learning Outcome
1	Introduction to Industrial Marketing, Differences between Industrial & Consumer Marketing, Types of B2B products – Heavy and Light equipments, systems, raw and processed materials, consumable supplies, components and industrial services	Lecture and Class room discussions	To understand basics of B2B marketing
2	Industrial Marketing Environment, Types of Customers, Types of buying situations, Key challenges – Managing commoditization of products, hybrid channels, CSR issues.	Lecture and Class room discussions	To understand Industrial marketing environment
3	Segmentation of B2B – Product/Applications matrix, Differences in customer strategy, Types of segmentation: Needs approach, Identifiable/Accessible approach, Shapiro-Bonoma Nested Hierarchy approach - Demographics, Operation variables, purchasing approaches, situational factors, buyer's personal characteristics	Lecture and Class room discussions	To understand segmentation parameters in B2B marketing
4	Market selection: Horizontal vs vertical choice in the value chain. Product form, consequences of resource commitment by the firm across the value chain.	Lecture and Class room discussions	To understand the consequences of investment decisions in identifying markets.
5	Specialty vs. commodity markets: Types of specialities – convenience specialty, availability specialty, functional specialty, relationship specialty.	Lecture and Class room discussions	To understand dynamics of B2B from specialty to commodity.

S. No	Content	Activity*	Learning Outcome
	Types of commodities – Pure commodities, price/performance commodities Dynamics of commodity market and commoditization process		
6	B2B Product Decisions – Service augmentation, Product-Service bundling, Product/ Process innovation, Service innovation.	Lecture and Class room discussions	To understand strategies for value added products and services.
7	Types of customer benefits in B2B markets: Tangible financial benefits, non-tangible financial benefits, tangible non-financial benefits, non-tangible non-financial benefits, loyalty benefits, B2B branding – Ingredient branding	Lecture and Class room discussions	To understand different types of customer benefits.
8	Models of organisational buying behaviour: Sheth BUYGRID model – Webster Wind model Developing buyer-seller relationships – Dwyer's 5 phases	Lecture and Class room discussions	To understand various models of organisation buying behaviour
9	Key Account Management: Definition, Drivers – Rise of global customers, JIT. Selection of Key Accounts – Criteria, Analysis of buying process	Lecture and Class room discussions	To understand how to identify and manage key accounts.
10	Firm networks: Uppsala Model (Johanson and Vahlne), Transaction cost theory (Rugman and Williamson), Business Ecosystem (Moore). Network formation – Alliances , JV, Decomposition of value chains, Role of networks in dominant design	Lecture and Class room discussions	To understand the importance of developing a competitive advantage in dominant designs

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Book

1	Business to Business Marketing, Havaldar : IInd Edition, McGraw Hill
2	Industrial Marketing Robert, Reeder
3	Ingredient Branding, Kotler , Springer

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**IV-Elective**			
Title of the Subject / course	**:**	**International Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

1 To develop an understanding of key issues in marketing across borders
2 To study the impact of various factors on a firm's business model and entry modes in international markets

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No.	Content	Activity*	Learning Outcomes
1	Competing in international markets: advantages of going global; **Market Analysis:** infrastructure, use of proxies like electricity/steel production to estimate markets where data is lacking/unreliable. Internet/mobile penetration etc.	Lecture / Case study discussions	To understand issues in deciding whether the firm should go global and the trade-offs involved
2	**Market Entry Strategies:** types of entry, determinants of entry – consumer behavior, demographics, Country of origin, national brand preferences; Free trade agreements with other countries, legal and regulatory barriers etc.	Lecture / Case study discussions	To understand issues which determine which country to enter
3	**Segmentation of markets:** identifying segments in countries/regions to target with a marketing programme, Positioning (common/ country-specific), consistency of product messages across countries, universal themes to connect consumers globally.	Lectures/Case discussions / field visits to MNCs / Exporters	Understanding STP in the global context
4	**International Market Research:** Primary and secondary research, issues in field studies, quality and availability of data, challenges and limitations of international market research	Lecture / Case study discussions	To understand challenges in international market research
5	**Product adaptation:** Keegan's matrix, balance between customization and standardization of products, impact of culture, economy, and country innovativeness on diffusion of innovation, legal issues in packaging including the impact of WTO Sanitary and Phyto-sanitary standards (SPS)	Lecture / Case study discussions	Understand issues in product diffusion globally

6	**Global branding:** Kotler and Keller's "10 commandments of Global branding", consistency of brand cultures, role of different authors on branding : popular culture, company, consumers, influencers	Lecture / Case study discussions	Understand how to build global brands
7	**Pricing:** importance of gray channels, pricing corridor, transfer pricing and dumping in international markets	Lecture / Case study discussions	Understand issues in pricing decisions
8	**Promotions:** legal and cultural issues in promotions across borders; difficulties in translating into foreign languages and blunders thereof	Lecture / Case study discussions	To understand the issues in cross-cultural promotions
9	**Channel management:** complexity in different methods of product distribution, addressing issues, Omni channels, cultural issues determining channel choices, conflicts and resolution	Lecture / Case study discussions	To understand strategic issues in managing channels across borders
10	**INCOTERMS:** Letter of credit – implications and cautions, DA/DP, FOB,C&F, CIF, FAS etc.	Lecture / Case study discussions	To understand incoterms in international trade

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Text and Reference books

1	Global Marketing, Warren J. Keegan, Mark C. Green, Pearson
2	International Marketing, Vern Terpstra, James Foley, Naper publishing group
3	Global Marketing Management, Masaki Kotabe, Wiley

Assessment

Internal	40%
Semester-end	60%

Semester	**:**	**IV-Elective**			
Title of the Subject / course	**:**	**Trends in Marketing**			
Course Code	**:**				
Credits	**:**	**4**	**Duration**	**:**	**40**

Learning objectives

To develop an appreciation of the impact of rapidly changing environment on marketing strategies and giving insights to students to respond to these changes.

Prerequisites if any	
Connections with Subjects in the current or Future courses	

Module

No	Content	Activity*	Learning Outcomes
1	Overview of trends: Collaborative marketing, the globalization paradox, impact of new technologies and global production and consumption.	Lecture	Understanding the impact of key drivers on marketing programs.
2	UN Millennium Development Goals: Concepts, cause related marketing, social marketing, Marketing of environmental friendly products	Lecture	To understand the impact of marketing on society
3	Marketing of Non-profit organizations – concepts, characteristics, differentiation – image management, image causation, and satisfaction measurement.	Lecture/ Case discussion	To understand the marketing issues related to non-profit organizations.
4	Marketing to the Bottom of Pyramid (BoP): Challenges in BoP market, constraint consumer decision making and BoP. Overcoming barriers to diffusion of innovation in BoP markets, innovative pricing, promotion, distribution, communication for BoP markets.	Lecture	Understanding characteristics of BoP markets.
5	Marketing of Luxury Goods: Trend towards premiumization, characteristics of luxury goods,	Lecture/ Case discussion	To understand marketing dynamics of luxury goods
6	Experiential Marketing – Customer expectation and experience	Lecture/ Case discussion	To understand experiential marketing
7	Recent practices in Marketing: Price – Freemium, Place-E-commerce, Inflight, etc. Product, Promotion-YouTube, OOH, etc.	Lecture/ Case discussion	To understand the recent practices in marketing

No	Content	Activity*	Learning Outcomes
8	Data driven Marketing: Use of big and small data for marketing decisions, privacy issues	Lecture/ Case discussion	To understand ethical issues in data driven marketing
9	Technology in Marketing – Internet of Things (IOT)/Information and Communication Technology (ICT)	Lecture/ Case discussion	To understand use of technology in marketing
10	Cyberwarfare – Role in competitor intelligence	Lecture/Case discussion	To understand new ways of attacking competition

***Activity:** Teaching-Learning process may combine the use of role plays, audio-visual films/aids, and management exercises with individual student, and or in team considering appropriate cases or case-lets in the field of business domain wherever applicable.

Recommended Book

1	Marketing in the Cyber Era: Strategies and Emerging Trends	Ali Ghobrani published by IGL Global
2	Marketing 3.O	Phillip Kotler
3	Fortune at the Bottom of Pyramid	C.K. Prahalad
4	Handbook on Management of Non-Profit Organizations	Easo John
5	Social Marketing Perspectives and Viewpoints	Lazer, William
6	I have a dream	Rashmi Bansal
7	The Core Competence of the Corporation	C.K. Prahalad & Gary Hamel
8	The Future of Competition	C.K. Prahalad & Venkat Ramaswamy (2004)
9	The New Age of Innovation	M. S. Krishnan & C.K. Prahalad
10	Analysis for Marketing Planning	Lehman & Winer
11	Strategic Marketing	Shahjahan
12	We are like that only	Rama Bijapurkar

Assessment

Internal	40%
Semester-end	60%