

**Additional Information for QnM 1.1.2**

**Number of Programmes where syllabus revision was carried out during the year 2022-23**

File description: Number of Programmes

Due to size constraints, only the syllabus of Biomedical Engineering is shown here. The entire program structure is available on our website [www.vit.edu.in](http://www.vit.edu.in). The specific links of the programs in which the syllabus revision is carried out are as below.

Sr No	Program Name	Website Link
1.	Undergraduate Bachelor of Information Technology	<a href="https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_INFT_Autonomy%20Scheme_BTech.pdf">https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_INFT_Autonomy%20Scheme_BTech.pdf</a>
2.	Undergraduate Bachelor of Computer Engineering	<a href="https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_CMPN_Autonomy%20Scheme_BTech_10Oct%202022.pdf">https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_CMPN_Autonomy%20Scheme_BTech_10Oct%202022.pdf</a>
3.	Undergraduate Bachelor of Electronics Engineering	<a href="https://vit.edu.in/images/syllabus/ETRX_TE_2019.pdf">https://vit.edu.in/images/syllabus/ETRX_TE_2019.pdf</a>
4.	Undergraduate Bachelor of Electronics and Computer science	<a href="https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_EXCS_Autonomy%20Scheme_BTech_10th%20Oct%202022.pdf">https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_EXCS_Autonomy%20Scheme_BTech_10th%20Oct%202022.pdf</a>
5.	Undergraduate Bachelor of Electronics and Telecommunication	<a href="https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_FINAL_VIT_EXTC_Autonomy%20Scheme_10th%20October%202022.pdf">https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_FINAL_VIT_EXTC_Autonomy%20Scheme_10th%20October%202022.pdf</a>
6.	Undergraduate Bachelor of Biomedical Engineering	<a href="https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_BIOM_Autonomy%20Scheme_BTech%2010%20Oct_2022.pdf">https://vit.edu.in/images/syllabus/Autonomy%20Syllabus/2022_Final_VIT_BIOM_Autonomy%20Scheme_BTech%2010%20Oct_2022.pdf</a>
7.	Postgraduate Master of Computer Engineering	<a href="https://vit.edu.in/images/syllabus/computer/2022_Final_VIT_CMPN_Autonomy%20Scheme_MTech.pdf">https://vit.edu.in/images/syllabus/computer/2022_Final_VIT_CMPN_Autonomy%20Scheme_MTech.pdf</a>
8.	Postgraduate Master of Electronics and Telecommunication Engineering	<a href="https://vit.edu.in/images/syllabus/telecommunication/PG-Syllabus.pdf">https://vit.edu.in/images/syllabus/telecommunication/PG-Syllabus.pdf</a>
9.	Postgraduate Master of Management Studies	<a href="https://vit.edu.in/images/syllabus/Syllabus_MMS.pdf">https://vit.edu.in/images/syllabus/Syllabus_MMS.pdf</a>



# Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Biomedical Engineering

First Year Scheme & Syllabus

(As per AICTE guidelines, with effect from Academic Year 2022-23)

## 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. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. Autonomy curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. Number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by third year of the engineering programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begins from third year of programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learner capable to work in industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness - Body, Mind & Spirit, Indian Traditional Knowledge System under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on minor/honours degree that involves field/ domain study. Learner can avail this degree by completing requirement of additional 15 credits. Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies  
Department of Biomedical Engineering  
Vidyalankar Institute of Technology

Chairman, Academic Council  
Vidyalankar Institute of Technology

**First Year B. Tech. Biomedical Engineering**

**Semester: I**

**Course Structure and Assessment guidelines**

Sr. No.	Course			Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Head of Learning	Name		ISA	MSE	ESE	
1	HS01	Theory	Effective Communication	02	15	20	40	075
		Practical	Effective Communication	1	25	-	25	050
2	BS02	Theory	Engineering Mathematics-I	3	20	30	50	100
3	BS20	Theory	Physics for Biomedical Engineering	2	15	20	40	075
		Practical	Physics for Biomedical Engineering	1	25	-	25	050
4	ES04	Theory	Structured Programming	2	15	20	40	075
		Practical	Structured Programming	1	25	-	25	050
5	ES08	Theory	Basic Electrical & Electronics Engineering	2	15	20	40	075
		Practical	Basic Electrical & Electronics Engineering	1	25	-	25	050
6	ES02	Theory	Engineering Mechanics	2	15	20	40	075
		Practical	Engineering Mechanics	1	25	-	25	050
7	GEXXX*	As per course	Any GE course	As per course				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

\* Refer to Appendix A for the list of General Education (GE) courses. Selection will be based on the subset of GE courses made available by the Institute for the semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**First Year B. Tech. Biomedical Engineering**  
**Course Structure and Evaluation Scheme**

**Semester: II**

Sr. No.	Course			Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Head of Learning	Name		ISA	MSE	ESE	
1	HS02	Theory	Professional Skills	2	15	20	40	075
		Practical	Professional Skills Lab	1	25	-	25	050
2	BS04	Theory	Engineering Mathematics-II	3	20	30	50	100
3	BS16	Theory	Engineering Chemistry	2	15	20	40	075
		Practical	Engineering Chemistry Lab	1	25	-	25	050
4	ES01	Theory	Engineering Graphics	2	15	20	40	075
		Practical	Engineering Graphics Lab	1	25	-	25	050
5	ES05	Theory	Object-Oriented Programming	2	15	20	40	075
		Practical	Object-Oriented Programming Lab	1	25	-	25	050
6	GEXXX*	As per course	Any two GE courses	As per course				
7	GEXXX*	As per course		As per course				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

\* Refer to Appendix A for the list of General Education (GE) courses. Selection will be based on the subset of GE courses made available by the Institute for the semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

## Detailed Syllabus of First Year Semester-I

**Course Name:** Effective Communication

**Course Code:** HS01

**Category:** Humanities, Social Sciences and Management Courses

**Preamble:**

This course introduces learners to the basics of Effective Communication and English language usage which will equip them with the requisite skillset for higher studies and placements. It considers the important foundational aspects of communication skills and English proficiency required for the workplace. It acquaints the learners with modern communication tools and the basics of public speaking before an audience.

**Pre-requisites:**

Basic English usage

**Course Objectives:**

- To enable learners to gain understanding of the cyclic process, methods, channels, and barriers of communication.
- To facilitate learners in developing the skills of active listening, impactful public speaking, reading strategies, and effective writing.
- To create awareness of strengthening English proficiency for competitive exam preparation and the art of comprehension and summarization.
- To introduce strategies for creating effective presentations using modern ICT enabled tools.

**Course Outcomes:**

Learner will be able to:

CO1: Use verbal/non-verbal cues at social and workplace situations by learning the basics of communication skills.

CO2: Employ listening strategies to become effective listeners and powerful speakers for speaking at social, academic and business situations.

CO3: Improved verbal aptitude to be equipped for competitive examinations and placements.

CO4: Make effective presentations and present before an audience with confidence.

CO5: Use reading strategies for faster comprehension, summarization and evaluation of texts.

CO6: Develop awareness of contemporary digital tools of communication.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Fundamentals of Communication	Concept, Elements and Cycle of Communication Methods of Communication (Verbal and Nonverbal) Objectives and Channels of Communication (Formal and Informal) Barriers to Communication: Physical, Mechanical, Psychological, Semantic, Socio-cultural, Cross-cultural	10
2	Listening & Speaking	Techniques to improve Listening, Listening exercises Speech writing and delivery Different types of Speeches & Tips on Public Speaking	6
3	English Usage	Vocabulary Building (Etymology, Synonyms, Antonyms, One Word Substitutes) useful for TOEFL, GRE Grammar Proficiency Tests (Articles, Prepositions, Tenses, Punctuation) Identifying Common Errors in Writing Grammar Checkers and Sentence Correction Tools	4
4	Presentation Skills	Introduction to Presentation Skills Creating Presentations-Content Delivering Presentations before an audience Using Presentation Software-Modern Presentation Tools	4
5	Comprehension & Summarization	Comprehension & Reading Strategies Graphic Organizers (Mind Maps, Flow Charts, Tree Diagrams etc.) Summarization of technical passages within specified word limit	2
6	Communication Strategies for Virtual Age	Digital Content Creation Infographics, ICT Tools Social and Popular Media	4
<b>Total</b>			<b>30</b>



**Suggested list of Practicals:**

1. Ice Breakers/Introduction/Aptitude Test/English Proficiency Test
2. Extempore Speech Practice Session
3. Prepared Speech
4. Group Presentations on current and relevant topics
5. Situational Dialogue Writing and Delivery
6. Skits/Role play on Methods of Communication and Barriers of Communication
7. English Usage Practice on Grammar and Vocabulary
8. Virtual Lab

**Suggested list of Assignments:**

1. Written Assignment on Fundamentals of Communication (Individual)
2. Listening Activities and Exercises (Individual)
3. Aptitude test on Vocabulary and Grammar (Language Lab) (Individual)
4. Presentation on domain related topics (Group)
5. Comprehension & Summarization of technical passages
6. Digital Content Creation using ICT Tools

**Suggested List of Value-Added Home Assignments:**

1. <https://www.udemy.com/course/professional-communication-and-business-writing/> Udemy
2. <https://www.udemy.com/courses/business/communications/> Udemy

**Suggested Online Courses:**

1. Courses on Communication offered by Udemy
2. Business English for Non-Native Speakers Offered by The Hong Kong University of Science and Technology  
[https://www.coursera.org/Specializations/Business English for Non-Native Speakers](https://www.coursera.org/Specializations/Business%20English%20for%20Non-Native%20Speakers)
3. English Communication Skills offered by University of Washington  
<https://www.coursera.org/specializations/Business> English Communication Skill
4. [https://www.udemy.com/share/101wx6/Public Relations: Media Communication Crisis](https://www.udemy.com/share/101wx6/Public%20Relations%3A%20Media%20Communication%20Crisis)
5. <https://www.udemy.com/share/101BkA/Basic> English Grammar and Structures

**Reference Books:**

1. Raman Meenakshi and Sangeeta Raman, "Communication Skills", OUP, 2016.
2. Kumar Sanjay and Pushp Lata, "Communication Skills", OUP, 2011.
3. Murphy Herta, "Effective Business Communication", McGraw Hill, 2017.
4. Kitty O Locker, "Business Communication- Building Critical Skills", McGraw Hill, 2013.
5. Lehman, Dufrene, Sinha, "BCOM" Cengage Learning, 2020.

6. K. Alex, "Soft Skills", S.Chand and Company, 2014.
7. Stanton Nicky, "Mastering Communication", Palgrave Master Series, 2009.
8. Alan Pease, "Body Language", Manjul Publications, 2014.
9. A. Kaul, "Effective Business Communication", Prentice Hall of India, 2015
10. Monippally, "Business Communication Strategies", Tata McGraw Hill, 2001.

**Course Name:** Engineering Mathematics-I

**Course Code:** BS02

**Category:** Basic Science

**Preamble:**

The objective of the course is to develop the basic Mathematical skills of engineering learners 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. learners impart knowledge of De-Moivre's Theorem, Hyperbolic Functions, and Logarithm of Complex Numbers. The course clarifies the concept of Partial Differentiation and its applications. The course will enable learners to learn basics of Successive Differentiation, Matrices, system of linear equations, Expansions of function and Transcendental Equations.

**Pre-requisites:**

Basics of Complex Numbers and Differentiation

**Course Objective:**

- To recall and remember basics of Complex, Successive differentiation and transcendental equations
- To apply methods to solve engineering problems.
- To solve and evaluate the problems using Complex, Successive differentiation and transcendental equations
- To analyze problems based on System of Linear Equations

**Course Outcomes:**

Learner will be able to:

CO1: Illustrate the basic concepts of Complex Numbers and solve problems involving different forms and properties of Complex Numbers.

CO2: Apply the knowledge of complex numbers to solve problems in Hyperbolic Functions and Logarithmic function.

CO3: Illustrate the basic principles of Partial Differentiation, Homogeneous functions, and Composite functions.

CO4: Illustrate basic principles of Maxima and Minima and Successive Differentiation.

CO5: Apply principles of basic operations of Matrices, Rank, and echelon form of matrices to solve simultaneous equations.

CO6: Illustrate the concept of Transcendental Equations, linear algebraic equations, and Expansions of functions..

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100
Practical	-	-	-	-

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Complex Numbers	Statement of D’Moivre’s Theorem. Expansion of $\sin n\theta$ , $\cos n\theta$ in terms of sines and cosines of multiples of $\theta$ and Expansion of $\sin n\theta$ , $\cos n\theta$ in powers of $\sin\theta$ , $\cos\theta$ , Powers and Roots of complex numbers.	7
2	Hyperbolic Function and Logarithm of Complex Numbers	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. Logarithmic functions, Separation of real and imaginary parts of Logarithmic Functions.	7
3	Partial Differentiation and Applications	Partial Differentiation: Function of several variables, Partial derivatives of first and higher order. Differentiation of composite function. Euler’s Theorem on Homogeneous functions with two independent variables (with proof). Deductions from Euler’s Theorem. Maxima and Minima of a function of two independent variables, Jacobians of two and three variables	8
4	Successive Differentiation & Expansion of Functions	Successive differentiation: nth derivative of standard functions. Leibnitz’s Theorem (without proof) and problems.  Taylor’s Theorem (Statement only) and Taylor’s series, Maclaurin’s series (Statement only). Expansion of $\sin(x)$ , $\cos(x)$ , $\tan(x)$ , $\sinh(x)$ , $\cosh(x)$ , $\tanh(x)$ , $\log(1+x)$	8

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
5	Matrices	Rank of a Matrix using Echelon forms, reduction to normal form and PAQ form. System of homogeneous and non-homogeneous equations, their consistency and solutions.	8
6	Numerical Solutions of Transcendental Equations and linear algebraic equations,	Solution of Transcendental Equations: Solution by Newton Raphson method and Regula – Falsi method. Solution of system of linear algebraic equations, by Gauss Jacobi Iteration Method, Gauss Seidal Iteration Method.	7
<b>Total</b>			<b>45</b>

**Text Books:**

1. Ramana B.V., "Higher Engineering Mathematics", 12th edition, Tata McGraw Hill, 2017

**Reference Books:**

1. Dr. B.S. Grewal, "Higher Engineering Mathematics", 9th Edition, Khanna Publication, 2012
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, Wiley Eastern limited, 2012
3. Srimanta Pal and Subidh C. Bhunia, "Advanced Engineering Mathematics", UK Edition, Oxford Press, 2015
4. H.K. Das, "Advanced Engineering Mathematics", 17th Edition, S, chand, 2008
5. Howard Anton and Christ Rorres "Elementary Linear Algebra with Applications", 5th edition, John Wiley 2012

**Course Name:** Physics for Biomedical Engineering

**Course Code:** BS20

**Category:** Basic Science

**Preamble:**

Most of the engineering branches are being off spring of basic sciences where physics is playing a pivotal role in concept and understanding the foundation of core engineering branches. Physics prepares students to apply physics to tackle 21st century engineering challenges, and to apply engineering to address 21st century questions in physics.

The course will develop the student awareness in semiconductor devices and quantum Physics The student will develop an informed appreciation of the paradigm shift already in evidence in technologies behind modern services and products. He will possess basic physics knowledge to pursue simulation and modelling of the semiconductor systems.

**Pre-requisites:**

12<sup>th</sup> Std. Physics, Basic Mathematics

**Course Objective:**

- Identify and understand the fundamental physical principals underlying engineering devices and processes— a prerequisite to become successful engineers.
- To provide inclusive knowledge of fundamental physical principles encouraging engineering students to venture into the research field.
- To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.
- To give exposure to the topics of fundamental physics in semiconductor and Laser.

**Course Outcomes:**

Learner will be able to:

CO1: Understand the concept of thin film technology using interference and diffraction.

CO2: Understand the band theory of solids and the carrier concentration in solids

CO3: Analyse the charge distribution and charge transport processes in semiconductors

CO4: Apply the knowledge of Fermi level in semiconductors and applications of semiconductors in electronic devices

CO5: Understand different methods to generate ultrasonic waves

CO6: Illustrate the working principle of various lasers and quantum processes

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**. Detailed Syllabus:**

Module No.	Module Name	Module Contents	No. of Hours
01	Fundamentals of Optics	Interference by division of amplitude, Interference in thin film of constant thickness due to reflected and transmitted light; Wedge shaped film; Newton's rings. Diffraction: Fraunhofer diffraction at single slit, Diffraction Grating, resolving power of a grating; Determination of wavelength of light using plane transmission grating	5
02	Semiconductor Physics	Band theory of solids, Classification of semiconductors. Fermi-Dirac statistics, carrier concentration in semiconductors. Concept of Fermi energy level, its position and variation with temperature and impurity concentration.	5
03	Semiconductor Conductivity	Intrinsic carrier density, mobility, and conductivity. Carrier diffusion, drift, and resistance. Electrical conduction in extrinsic semiconductor. Diffusion length and mean lifetime. Hall Effect.	5
04	Semiconductor Devices	Physics of p-n junctions. Fermi level - in equilibrium, in forward and in reverse bias. Band bending in forward and reverse bias junction Introduction to two terminal devices – Rectifier diode, LED, Zener diode, PIN diode, Solar Cell, Schottky diode etc.	5
05	Physics of Sound	Ultrasonic Wave generation; Magnetostriction Oscillator; Piezoelectric Oscillator. Applications of ultrasonic: Eco sounding; NDT; ultrasonic cleaning(cavitation); ultrasonic	4

Module No.	Module Name	Module Contents	No. of Hours
		sensors; Industrial applications of ultrasonic (soldering, welding, cutting, drilling)	
06	Lasers	Radiation Matter Interactions, Einstein's coefficients. Basics of Laser- Population inversion, Pumping, Optical Resonator, Metastable state etc. Laser Beam Characteristics. Laser Systems - Ruby laser, He-Ne Laser, Semiconductor Laser, Nd-YAG Laser. Engineering applications of Laser.	4
07	Introduction to Quantum Physics	De Broglie hypothesis of matter waves; properties of matter waves. Physical interpretation of wave function Introduction to Schrodinger's equations	2
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

1. Half Wave Rectifier
2. Full Wave Rectifier
3. Electric Motor
4. Transformer
5. Transistor as a switch
6. Transistor in CB and CE mode
7. Energy Band of a Semiconductor
8. Hall Effect
9. Light Emitting Diode
10. Solar Cell
11. Zener Diode
12. PN-junction diode
13. Wavelength of LASER using grating
14. Divergence of LASER beam
15. Groove depth of CD using LASER
16. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method.
17. Determination of refractive index of water using Newton's Ring.

**Suggested Online Courses:**

1. Physics of silicon solar cells Offered by École Polytechnique.  
<https://www.coursera.org/learn/physics-silicon-solar-cells>
2. Semiconductor Physics Offered by University of Colorado Boulder  
<https://www.coursera.org/learn/semiconductor-physics>

**Text Books:**

1. S.M. Sze, "Physics of Semiconductor Devices", John Wiley



2. B. Streetman, and S. Banerjee "Solid State Electronics", Prentice Hall India, 2006
3. R.P. Feynman, "The Feynman Lectures on Physics (Vol. 1-3)", Narosa 2008
4. I.S. Tyagi, "Principles of Quantum Mechanics", Pearson Education 2013
5. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson
6. R Shankar , "Principles of Quantum Mechanics", second edition.
7. Brij Lal and Subramaniam "Optics", S. Chand.

**Reference Books / Articles**

1. <http://dsc.discovery.com/tv-shows/curiosity/topics/10-ways-quantum-physics-will-change-world.htm>
2. <http://dsc.discovery.com/tv-shows/curiosity/topics/10-real-world-applications-of-quantum-mechanics.htm>
3. Leonard I. Schiff, "Quantum Mechanics", McGraw Hill/ Asia, Edition 3

**Course Name:** Structured Programming

**Course Code:** ES04

**Category:** Engineering Science

**Preamble:**

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

**Course Objectives:**

1. The course aims to provide exposure to problem solving through programming
2. It aims to train students the basic concepts of C programming language
3. The course involves a lab component to give students hands on experience with the concepts
4. It aims to provide exposure to handling data through files

**Course Outcomes:**

Learner will be able to:

CO1: Understand the fundamentals of a programming language.

CO2: Apply the control structures for code optimization and hence improving efficiency.

CO3: Decompose a problem and solve it using modular programming.

CO4: Demonstrate the use of derived and user derived data types for collection and processing of data.

CO5: Understand the concept of pointers and files to solve the problems related to dynamic and persistent data.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Fundamentals of C	Character Set, Identifiers and Keywords, Data Types, Constants and Variables Operators, Math Library Functions, Expressions, Pre-processor Directives	4
2	Input and Output	Unformatted and Formatted I/O Function scanf( ) Function printf( ) Concept of Field width, Precision and Flags Basic Programs Based on Computation	2
3	Control Structures	Conditional Branching - if, if-else statement, nested if-else, and switch-case statement. Looping – for loop, while and do-while loop, nested loops Unconditional Branching – break and continue statement	6
4	Functions	Introduction of Functions Declaration and definition of a Function Calling a Function and passing arguments to a Function Concept of Global and Local Variables Storage Classes –Auto , Extern , Static, Register Recursion	6
5	Arrays, Strings and Structures	Array-Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array. String- Basic of String, Array of String , Functions in string. h Structure- Declaration, Initialization, Nested structure, Operation on structures, Array of Structure.	6
6	Pointers and Files	Pointer: Pointer Variables, Reference and Dereference Operators, void Pointer, Call by Reference, Pointer Arithmetic, Pointer to Pointer, Pointers and Array, Passing Arrays to Function, Array of Pointers and Dynamic Memory Allocation. Files: Types of File, File operation- Opening, Closing, Creating, Reading, Processing File.	6
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

Learners are expected to perform minimum 12 practicals based on the following suggested topics.

Sr. No.	Suggested Topic(s)	Number of Experiments
1	Computation Based Programs	1

Sr. No.	Suggested Topic(s)	Number of Experiments
2	Programs using if .. else and nested if .. else	2
3	Programs using switch case	2
4	Programs using for loop	3
5	Programs using while loop	2
6	Programs on Functions	2
7	Programs on Recursion	2
8	Programs using 1D and 2D Arrays	3
9	Programs using Strings	2
10	Programs on Structures	2
11	Programs using Call by Reference	1
12	Programs using Dynamic Memory Allocation	1
13	Programs on Files	2

**Text Books:**

1. K. R. Venugopal and Sudeep Prasad, "Mastering C", Tata McGraw Hill.
2. Behrouz Forouzan "A Computer Science –Structure Programming Approaches using C", Cengage Learning.
3. Byron S. Gottfried, Schaum's outlines "Programming with C" - Tata McGraw Hill.

**Reference Books:**

1. M. G. Venkateshmurthy," Programming Techniques through C", Pearson Publication.
2. E. Balaguruswamy, "Programming in ANSI C ", Tata McGraw- Hill Education.
3. Pradeep Day and Manas Gosh "Programming in C", Oxford University Press
4. Yashwant Kanetkar "Let Us C", BPB Publication

**Course Name:** Basic Electrical Engineering

**Course Code:** ES08

**Category:** Engineering Sciences

**Preamble:**

This course introduces learners to basic techniques for electrical circuit analysis.

**Pre-requisites:**

1. Current Electricity, Electromagnetic Induction, Electromagnetism.
2. Complex numbers and Matrices

**Course Objectives:**

- To enable learners to gain understanding of the D.C circuit analysis and different network theorem
- To facilitate learners in developing the skills analysing single and three phase AC circuits.
- To create awareness of single-phase transformer working.
- To introduce electrical machines applications.

**Course Outcomes:**

Learner will be able to

1. Evaluate DC circuits using different network theorems.
2. Evaluate 1- $\Phi$  circuit and 3- $\Phi$  AC circuits.
3. Illustrate the constructional features and operation of 1- $\Phi$  transformer.
4. Understand different types of DC and AC motors.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	DC Circuits (Only Independent Sources)	Kirchhoff's Laws, Ideal and practical voltage and current Sources, Source Transformation, Star-Delta / Delta-Star Transformations, Mesh and Nodal Analysis, Superposition Theorem Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.	10
2	AC Circuits	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	8
3	Three Phase AC circuits	Generation of Three-Phase Voltages, voltage & current relationships in Star and Delta Connections, Power Measurement	3
4	Single Phase Transformer	Working principle, EMF equation, Transformer losses, Comparison between Actual (practical) and ideal transformer, Performance parameters, Phasor diagram	5
5	Motors and applications	DC motors, AC motors, Servo motors, Stepper motors, BLDC and their applications.	4
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

- To measure output voltage across load resistor/current through load resistor and verify the result using Mesh and Nodal analysis.
- To verify of Superposition Theorem.
- To verify Thevenin's Theorem.
- To verify Norton's Theorem.
- To verify Maximum Power Transfer Theorem.
- To find the resistance and inductance of a coil connected in series with a pure resistance
- To find resonance conditions in a R-L-C series resonance circuit
- To measure relationship between phase and line, currents and voltages in three phase system (star & delta)
- To measure Power and phase in three phase system by two wattmeter method.
- To find the equivalent circuit parameters by conducting OC and SC test on single phase transformer

**Text Books:**

- V. N. Mittal and Arvind Mittal "Basic Electrical Engineering" Tata McGraw Hill, (Revised Edition)
- Vincent Del Toro "Electrical Engineering Fundamentals", PHI Second edition, 2011
- Edward Hughes "Hughes Electrical and Electronic Technology", Pearson Education (Tenth edition)
- D P Kothari and I J Nagrath "Theory and Problems of Basic Electrical Engineering", PHI 13th edition 2011.
- M. Naidu, S. Kamakshiah "Introduction to Electrical Engineering" McGraw-Hill Education, 2004
- B.R Patil "Basic Electrical Engineering" Oxford Higher Education, Revised Second Edition, 2018

**Reference Books:**

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

**Course Name:** Engineering Mechanics

**Course Code:** ES02

**Category:** Engineering Science

**Preamble:**

To improve the skill sets to understand forces and motions associated with particles and rigid bodies. This course also imparts and inculcate students to understand force system and its effects.

**Pre-requisites:**

Basic Mathematics and Physics

**Course Outcomes:**

Learner will be able to:

CO1: Ability to understand and analyse forces, force systems and equilibrium.

CO2: Understand and verify law of Moments.

CO3: Determine the centroid of plane lamina.

CO4: Evaluate co-efficient of friction between the different surfaces in contact.

CO5: Understand and apply basic concepts of Kinematics of particles and kinematics of rigid bodies.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.



**Detailed Syllabus:**

Module No.	Module name	Content	No. of Hours
1	System of Coplanar Forces	Introduction to Force and Force systems (Concurrent, Parallel and General coplanar force system), resolution composition and resultant of force systems. Principle of transmissibility of a force, Moment of force about a point, Couples, Varignon's Theorem. Force couple system.	6
2	Centroid	First moment of Area, Centroid of Regular composite plane Laminas	4
3	Equilibrium	Equilibrium of rigid beams: Free body diagrams. Conditions of equilibrium. Types of supports & types of loads. Determination of supports reactions for different types of loads on the beams.	5
4	Friction	Coefficient of static and dynamic friction, Laws of friction, Angle of Friction, Angle of Repose. Concept of Cone of friction. Equilibrium of bodies on horizontal & inclined plane.	4
5	Kinematics of Particle	Uniformly accelerated motion along straight line, motion under gravity, Projectile Motion.	7
6	Kinematics of Rigid Bodies	Introduction to different types of motion a Rigid body performs viz. Translation, Rotation and General Plane motion. Concept of Instantaneous Centre of rotation (ICR) for the finding velocity. Locating ICR for multiple link mechanism. Velocity analysis of rigid body using ICR.	4
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

1. Verification of principle of moment /Bell crank Lever- By using simulation software
2. Determination of support reactions of simply supported beam -By using simulation software
3. Determination of coefficient of friction using inclined plane method - By using simulation software
4. Projectile Motion - By using simulation software
5. Verification of Law of Polygon of coplanar Forces- By using simulation software
6. Determine the Centroid of plane lamina - By using simulation software

**Text Books:**

1. A K Tayal, "Engineering Mechanics", 14<sup>th</sup> edition, Umesh Publication, 2010
2. K L Kumar, "Engineering Mechanics", 3<sup>rd</sup> edition, Tata McGraw-Hill, 2011
3. R. S. Khurmi, "Engineering Mechanics", 21<sup>st</sup> edition, S. Chand Publication, 2018

**Reference Books:**

1. R. C. Hibbeler, "Engineering Mechanics", 14<sup>th</sup> edition, Pearson Publication, 2020
2. Beer & Johnston, "Engineering Mechanics", 12<sup>th</sup> edition, Tata McGraw-Hill Education, 2019
3. F. L. Singer, "Engineering Mechanics", 2<sup>nd</sup> edition, Harper& Raw Publication, 1975
4. W. G. McLean & E. W. Nelson, "Engineering Mechanics", 12<sup>th</sup> edition, Tata McGraw- Hill Education, 2020
5. J. L. Meriam and L. G. Kraige, "Engineering Mechanics (Statics)", 7<sup>th</sup> edition, Wiley Books, 2011

## Detailed Syllabus of First Year Semester-II

**Course Name:** Professional Skills

**Course Code:** HS02

**Category:** Humanities, Social Sciences and Management Courses

**Preamble:**

The course will groom learners in the areas of developing professional etiquettes, building digital profiles, imbibing workplace ethics, and organizational behavior. This course will also be an essential guide in building business communication and soft skills concepts.

**Pre-requisites:**

Effective Communication

**Course Objectives:**

- To introduce the concepts of the job application process and digital profile building.
- To create awareness of professional etiquettes and corporate culture in tune with 21st Century soft skills.
- To enable learners to enrich their personality through self-awareness and SWOT analysis and understand various interpersonal skills required for the workplace.
- To build the foundations of professional ethics and corporate social responsibility among learners.

**Course Outcomes:**

Learner will be able to:

CO1: 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.

CO2: Acquire basic proficiency in building a digital profile by demonstrating an awareness of professional and ethical responsibilities.

CO3: Understand the nuances of professional etiquettes and professionalism.

CO4: Enrich their personality through SWOT analysis, identify their personality traits and learning styles

CO5: Develop interpersonal skills to build effective professional relations.

CO6: Demonstrate awareness of contemporary issues, knowledge of ethical responsibilities and CSR.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Employment Skills	Job Application & Resume Writing Group Discussion Interview Skills Digital Profile Building (ePortfolio, LinkedIn)	10
2	Professional Etiquettes	Corporate Grooming and Workplace Etiquette Telephone Etiquette Netiquettes Digital Footprints, Social Media, Personal Profile Privacy	4
3	Interpersonal Skills	Assertiveness, Negotiation Leadership, Team Building Problem Solving, Decision Making Cultural and Emotional Intelligence	6
4	Ethics	Introduction to Ethics Plagiarism and Online Plagiarism Checker Patents Trademark and Copyrights and GI – Geographical Indicators Professional Ethics Corporate Social Responsibility (CSR) Information Confidentiality	4
5	Personality Enrichment	SWOT Analysis and JOHARI window Developing Positive Attitude Personality Types and Learning Styles Vision and Goal Setting Stress Management and Time Management	4
6	21 <sup>st</sup> Century Skills	Creative Thinking Critical Thinking Collaboration and Communication	2
<b>Total</b>			<b>30</b>

**Suggested list of Practicals:**

1. Icebreakers – Introducing others
2. GD Practice Session
3. Final GD
4. Digital Profiling
5. Role Play on Professional Etiquettes
6. Personality Enrichment
7. Seminar on Interpersonal Skills
8. Case Studies on Ethics

**Suggested list of Assignments:**

1. Draft a Cover Letter and a Resume in response to a job vacancy advertisement (Individual)
2. Role plays and documentation on Professional Etiquettes (Group)
3. Role Play and documentation on Interpersonal Skills (Group)
4. Analysis of case studies on Ethics (Individual)
5. SWOT Analysis (Individual)
6. Assignment on 21<sup>st</sup> Century Skills Group)

**Suggested list of Online Courses:**

1. LinkedIn Mastery: Creating an awesome profile - <https://www.udemy.com/course/linkedin-mastery-creating-an-awesome-profile/>
2. Soft Skills: The 11 Essential Career Soft Skills - <https://www.udemy.com/course/soft-skills-the-11-essential-career-soft-skills/>
3. Understanding Personality Types at Work - <https://www.udemy.com/course/understanding-personality-types-at-work/>
4. Speak English Professionally: In Person, Online & On the Phone - <https://www.coursera.org/learn/speak-english-professionally>
5. How to Write a Resume (Project Centered Course) <https://www.coursera.org/learn/how-to-write-a-resume>
6. Interviewing and Resume Writing in English Specialization <https://www.coursera.org/specializations/english-interview-resume>
7. Build Your Professional ePortfolio in English - <https://www.coursera.org/learn/eportfolio-english>

**Reference Books:**

1. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 2021.
2. Dr. K.Alex, "Soft Skills", S. Chand and company, 2014.
3. Robbins Stephens, "Organizational Behaviour", Pearson Education, 2016.
4. Dorch, Patricia, "What Are Soft Skills?", Executive Dress Publisher, NewYork, 2013.
5. Francis Peter, "Soft Skills and Professional Communication", Tata McGraw Hill, 2019.
6. Kitty O Locker, "Business Communication- Building Critical Skills", McGraw Hill, Sixth Edition.
7. Chaturvedi and Chaturvedi, "Business Communication - Concepts Cases and Applications", Pearson, 2021.
8. Jones, "How to Speak Fluently", Indian Publishing House, 2021.

**Course Name:** Engineering Mathematics-II

**Course Code:** BS04

**Category:** Basic Science

**Preamble:**

The objective of the course is to develop the basic Mathematical skills of engineering learners 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, impart fundamental knowledge of Differential Equations of First Order, Higher Order, Special functions like Beta and Gamma Function, Double and Triple Integration, DUIS, Rectification, Numerical solutions of Differential Equations and Numerical Integration.

**Pre-requisites:**

Fundamentals of Integration and Differential Equations.

**Course Objective:**

- To recall and remember basics of differential equations, integral Calculus
- To apply methods to solve engineering problems.
- To solve and evaluate the problems using Multiple Integration, Numerical Integration.
- To analyze problems based on Numerical Methods for solving differential Equations

**Course Outcomes:**

Learner will be able to:

CO1: Illustrate the concept of Exact Differential equation and solution of various types of First Order First Degree Differential Equations.

CO2: Illustrate the concept of Complementary Function and Particular Integral and solution of Linear Differential Equations with constant coefficients.

CO3: Illustrate the concepts of Beta, Gamma function and DUIS .

CO4: Illustrate the concept of Double Integral in Cartesian and Polar form, change the order of Integration, Evaluate Double Integral over a given region.

CO5: Illustrate the concept of changing to polar coordinates in double integrals. Application of double integrals to compute Area, Evaluation of Triple Integration.

CO6: Illustrate the concept of Numerical solution of Ordinary Differential Equation, and Numerical integration using various methods.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100
Practical	-	-	-	-

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Differential Equations of First Order and First Degree	Exact differential Equations, Equations reducible to exact form by using integrating factors. Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation	7
2	Linear Differential Equations with Constant Coefficients and Variable Coefficients of Higher Order	Linear Differential Equation with constant coefficient-complementary function, particular integrals of differential equation of the type $f(D)y = X$ where $X$ is $e^{ax}$ , $\sin(ax + b)$ , $\cos(ax + b)$ , $x^m$ , $m$ is positive integer, $e^{ax}V$ , $xV$ or $X$ . Method of variation of parameters	8
3	Beta and Gamma Function and Differentiation under Integral Sign	Beta and Gamma functions and its properties. Differentiation under integral sign with constant limits of integration.	7
4	Multiple Integration-1	Double integration-definition, Evaluation of Double Integrals. (Cartesian & Polar), Evaluation of double integrals by changing the order of integration. Evaluation of integrals over the given region. (Cartesian & Polar)	8
5	Multiple Integration-2	Evaluation of double integrals by changing to polar coordinates. Application of double integrals to compute Area, Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates).	8



Programme Scheme and Syllabus (2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

Module No.	Module Name	Content	No. of Hours
6	Numerical solution of ordinary differential equations of first order and first degree, and Numerical Integration	Numerical solution of ordinary differential equation using Euler's method and Runge-Kutta fourth order method Numerical integration-by Trapezoidal, Simpson's 1/3rd and Simpson's 3/8th rule .	7
<b>Total</b>			<b>45</b>

**Text Books:**

1. Ramana B.V., "Higher Engineering Mathematics", 12th edition, Tata McGraw Hill, 2017

**Reference Books:**

1. Dr. B.S. Grewal, "Higher Engineering Mathematics", 9th Edition, Khanna Publication, 2012
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, Wiley Eastern limited, 2012
3. Srimanta Pal and Subidh C. Bhunia, "Advanced Engineering Mathematics", UK Edition, Oxford Press, 2015
4. H.K. Das, "Advanced Engineering Mathematics", 17th Edition, S. Chand, 2008
5. Howard Anton and Christ Rorres "Elementary Linear Algebra with Applications", 5th Edition, John Wiley 2012

**Course Name:** Engineering Chemistry

**Course Code:** BS16

**Category:** Basic Science

**Preamble:**

This course imparts learners sound knowledge on the fundamentals of chemistry which can be applied in various courses and projects taken in Electronics and Computer Science, Electronics and Telecommunication and Biomedical Engineering.

**Pre-requisites:**

Basic Chemistry

**Course Objectives:**

1. The contents of this course will aid in quantification and understand the applications of several concepts in Chemistry.
2. To appreciate the need for and importance of engineering chemistry for industrial and domestic use.
3. To gain the knowledge on existing and future upcoming materials used in device fabrication.
4. To impart knowledge of green chemical technology and its applications.
5. To enhance the thinking capabilities in line with the modern trends in engineering and technology.

**Course Outcomes:**

Learner will be able to:

CO1: Interpret properties, synthesis, and uses of important materials in various engineering applications.

CO2: Apply the fundamentals of electrochemistry in prevention & control measures related to corrosion of structures and devices.

CO3: Rationalise different types of batteries and their real-life engineering applications.

CO4: Analyse different spectroscopic techniques and study fundamentals of electromagnetic spectrum.

CO5: Associate Green Chemistry principles in product development knowledge.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Polymer Chemistry	Introduction to Polymer, Properties of Polymers- Molecular weight, numerical problems on molecular weight, Glass transition temperature Methods of polymerization, Synthesis, Properties and Uses of commercially important polymers, Study of Speciality polymers like Conducting polymers, Liquid Crystal Polymer etc., Applications of Polymers	6
2	Electrochemistry and Corrosion	Electrochemistry- Basics, Types of electrochemical cells, Electrochemical series and Galvanic series, Nernst equation, Numerical problems, Construction & Application of various electrodes Corrosion- Chemical and Electrochemical corrosion, Mechanism, Types- Differential aeration, Galvanic, Stress, Intergranular, Microbial, Soil corrosion etc., Prevention and control Measures, Case studies like- Corrosion in human body implants & Corrosion in electronic gadgets	6
3	Energy Storage systems	Fundamentals of Energy storage, primary cells and secondary cells, Types of Batteries, Construction and application of Li-Ion battery Fuel cells- principle, components of fuel cell, types of fuel cell, applications, advantages and disadvantages, hydrogen production and hydrogen storage system Numerical problems	4
4	Chemistry of Semiconductors	Silicon & Germanium - Physical and chemical properties, Isotopes, Chemistry of compounds like GaAs, GaP, InP. InGaAs, ZrO, HfO and applications in industry	3
5	Engineering Materials	Nanomaterials: Introduction, Graphene, Fullerenes, Carbon nanotubes, Electronic and Mechanical properties, Synthesis of CNT, Role of nano materials in electronics, Photonics, MEMS, Energy Nano-bio application	5

Module No.	Module Name	Content	No. of Hours
		Composite Materials: Types, properties, and industrial applications Shape Memory alloys: Principle, properties, super elasticity- One way and two-way shape memory effect, Austenite and martensite transformations, applications Smart Materials: Self-Assembled Nanostructures - Energy Harvesting Materials, Intelligent Materials – Magneto strictive Materials	
6	Spectroscopic techniques	Fundamentals of Spectroscopy, Electromagnetic spectrum, Different Forms of Spectroscopy, Beer-Lambert's law- Numerical problems, Techniques, Instrumentation and applications in Medicines and electronics	4
7	Green Chemistry	12 Principles of Green Chemistry & application in green computing & Green Electronics, Numerical problems	2
<b>Total</b>			<b>30</b>

#### Suggested List of Practicals:

1. To determine free acid pH of different solutions using pH meter
2. To determine the Wavelength of Maximum Absorbance using colorimeter.
3. To determine metal ion concentration using colorimeter.
4. To determine Molecular weight of polymers by Oswald Viscometer.
5. To synthesize UF, PF, Nylon 66.
6. To synthesize biodegradable polymer.
7. To determine Viscosity of oil by Redwood Viscometer
8. To separate pigments using paper chromatography.
9. To determine total, temporary, and permanent hardness of water sample by EDTA method.
10. To construct the battery and measure potential difference across two terminals
11. To identify the materials and learn their properties
12. To set up a galvanic cell
13. To set up an electrolytic cell and carry out electroplating
14. To carry out etching of the Printed Circuit Board (PCB)
15. To synthesize a nanomaterial and study its characterization
16. To detect the adulteration in given milk sample
17. Virtual experiment on Nanomaterial using open-source tool- [www.nanohub.org](http://www.nanohub.org)
18. Virtual experiments using open-source tool - <https://vlab.amrita.edu>

#### Text Books:

1. Shashi Chawla, "A Textbook of Engineering Chemistry", Dhanpat Rai & Co. (PVT.) LTD., New Delhi (2004).
2. S. S. Dara, "Engineering Chemistry", Chand & Co, New Delhi (2006)
3. Jain and Jain, "Engineering Chemistry", Dhanpat Rai & Co (PVT.) LTD, New Delhi (2006).

#### Reference Books:

1. B.R. Puri and L.R. Sharma, "Principles of Physical Chemistry", 45th Edition, Vishal Publishing Co. 2012.
2. Peter Atkins, Physical Chemistry, XI th ed, Oxford, United Kingdom, Oxford University Press, 2017
3. Green Chemistry: A textbook- V. K. Ahluwalia, Alpha Science International
4. Concise Inorganic Chemistry – J. D. Lee
5. V.R.Gowariker, "Polymer Science", New Age International Publication
6. S.K.Kulkarni, "Introduction to Nanotechnology"
7. Fundamentals of Molecular Spectroscopy (4th edition)- C. N. Banwell, Elaine M. McCash, Tata McGraw Hill.
8. Elementary Organic Spectroscopy- Y.R. Sharma, S. Chand and Co.
9. William D. Callister, Materials Science and Engineering: An Introduction, Wiley
10. Mel Schwartz, Smart Materials, CRC Press New York, 2009
11. Dimitris C. Lagoudas, Shape Memory Alloys, Springer, New York, 2008
12. Micky Rakotondrabe, Smart Materials- Based Actuators at Micro/Nano-Scale, Springer

**Course Name:** Engineering Graphics

**Course Code:** ES01

**Category:** Engineering Science

**Preamble:**

To improve the visualization skills of the students, with imparting the student's ability to read a drawing. This course also imparts and inculcate students to understand the theory of projection.

**Pre-requisites:** Basic Geometry

**Course Outcomes:**

Learner will be able to:

CO1: Understand conventional method and usage of CAD software.

CO2: Apply the basic principles of projections and visualization to communicate ideas graphically.

CO3: Construct the drawing of curves, points, straight lines, and planes using concept of projections.

CO4: Interpret the three-dimensional pictorial objects and represent in two-dimensional views.

CO5: Construct three dimensional shapes from two dimensional views using the concept of projections.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Introduction to Engineering Graphics and CAD	Introduction and importance of engineering graphics. Introduction of different types of the quadrants, method of projection, lines and dimensioning. Drawing instruments and their usage. Introduction Computer Aided Design and Drafting (CADD or CAD) software and operations, menu system and toolbars.	3
2	Engineering Curve	Basic construction of cycloid, involutes, and helix of cylinder.	4
3	Projection of points, lines	Projections of lines, inclined to both the reference planes HP and VP as per the first angle projection method.	4
4	Projection of Planes	Projection of rectangular, triangular, square, pentagonal, hexagonal, and circular planes, inclined to both the reference planes HP and VP as per the first angle projection method.	4
5	Orthographic Projections	Drawing orthographic views from pictorial projections. Sectional orthographic Projections of a simple machine part as per the first angle projection method. - By drafting in the sketchbook as well as on CAD software. CAD Drawing: Applying dimensions to objects, applying annotations to drawings, setting up and use of layers, changing of the line properties, Printing setup and procedure. Different CAD Tools and usage- Draw tools, modify tools, properties, copy selection, dimensioning and editing (text height and arrow size).	9
6	Isometric Views	Drawing Isometric views from given views of simple blocks with plane, cylindrical surfaces, and circular holes. - By drafting in the sketchbook as well as on CAD software CAD Drawing: Switching to isometric drafting mode, switch /change to different ISO planes, ISO circles on different ISO planes, Different CAD Tools and usage- Draw tools, Modify tools, Properties of line.	6
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

Learners are expected to perform minimum 12 practicals based on the following suggested topics, using Computer Aided Design (CAD) tool.

Sr. No.	Suggested Topic(s)	Number of Practicals
1	Orthographic Projection (Without Section)	4
2	Orthographic Projection (with section)	4
3	Isometric Views	4
4	Problem Based Learning (PBL) on AutoCAD	2

**Text Books:**

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", 53<sup>rd</sup> Edition, Charotar Publishing House Pvt. Ltd., 2014
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", 50<sup>th</sup> edition, Charotar Publishing House Pvt. Ltd. 2014
3. Dhananjay A Jolhe, "Engineering Drawing" 1<sup>st</sup> edition, Tata McGraw Hill, 2017

**Reference Books:**

1. Prof. Sham Tickoo (Purdue University) & Gaurav Verma, "(CAD Soft Technologies): Auto CAD 2012 (For engineers and Designers)", Dreamtech Press New Delhi, 2012
2. "Learning AutoCAD", Autodesk Official Training Guide, 2009



**Course Name:** Object Oriented Programming

**Course Code:** ES05

**Category:** Engineering Science

**Preamble:**

The course aims to advance learners knowledge in problem solving and programming principles for real world applications through object-oriented programming using Java language. The course emphasizes data abstraction and object-oriented programming design through the implementation of classes, objects and related concept like Inheritance, Polymorphism, Exception Handling, Multithreading and Applets.

**Course Objectives:**

1. The course aims to provide exposure to problem solving through object oriented programming
2. It aims to train students the basic concepts of Java programming language
3. The course involves a lab component to give students hands on experience with OOP concepts
4. It aims to provide exposure to develop a web based application

**Course Outcomes:**

Learner will be able to:

CO1: Apply fundamental Programming Constructs.

CO2: Illustrate the concept of packages, classes, and objects.

CO3: Elaborate the concept of strings, arrays, and vectors.

CO4: Implement the concept of inheritance and interfaces.

CO5: Implement the notion of exception handling and multithreading.

CO6: Develop web based applications.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	2	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075
Practical	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Introduction to Java	Features of Java, Platform Independence – Byte Code, JVM, JRE. Data Types Operators, Control Structures, Static Data, Static Function, 1D Array and 2D Array	5
2	Object Oriented Programming	Classes and Objects, Instance Variables, Constructors Object Passing Methods Method Overloading, Array of Objects	4
3	Inheritance	Concept and Types Constructors in Inheritance Method Overriding and Dynamic Method Dispatch, abstract and final keyword Interfaces – Concept and Significance Wrapper Classes – String, StringBuffer, Vector	8
4	Exception Handling	Concept of Exception, Types –Checked and Unchecked Use of throws keyword. try-catch-finally keywords. Throwing Exception manually User Defined Exceptions	5
5	Multithreaded Programming	Creating Thread – Different Methods Using Thread Methods, Thread Exceptions, Priorities Life Cycle of Thread Synchronization	5
6	Packages and Applets	Inbuilt Package, Importing Packages User Defined Packages, Naming Packages, Advantages of Packages Applet Basics, Applet Life Cycle Applet Drawing Methods,	5
<b>Total</b>			<b>30</b>

**Suggested List of Practicals:**

Learners are expected to perform minimum 12 practicals based on the following suggested topics.

Sr. No.	Suggested Topic(s)	Number of Practicals
1	Programs on Basic programming constructs like branching and looping	2
2	Program on accepting input through keyboard	2
3	Programs on class and objects	2
4	Program on method and constructor overloading.	2
5	Program on Packages	1

<b>Sr. No.</b>	<b>Suggested Topic(s)</b>	<b>Number of Practicals</b>
6	Program on 2D arrays, strings functions.	2
7	Program on String Buffer and Vectors.	2
8	Program on types of Inheritance.	1
9	Program on Multiple Inheritance.	1
10	Program on abstract class and abstract methods.	1
11	Program using super and final keyword.	1
12	Program on Exception handling.	2
13	Program on user defined exception.	2
14	Program on Multithreading.	3
15	Program on Graphics class.	2
16	Program on applet class.	2

**Text Books:**

1. Herbert Schildt "JAVA: The Complete Reference", Oracle Press
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in JAVA", Oxford University Press

**Reference Books:**

1. Ivor Horton "Beginning JAVA", Wiley, India
2. Dietal and Dietal "Java: How to program", Prentice Hall
3. Stevan Jolzner" JAVA Programming- Black Book", Dreamtech Press
4. Demics "Learn to Master Java Programming script", Staredu Solutions.

## Detailed Syllabus of General Education Courses

**Course Name:** Design Thinking

**Course Code:** GECI01

**Category:** General Education (Creativity and Innovation)

**Preamble**

Design thinking is a powerful tool for rethinking and revitalizing strategy—and for driving organizational performance. By placing customers' needs at the center of a product, service, process, or business model, you can reframe strategic challenges and develop more effective solutions. Drawing on right-brained creativity and left-brained analytics, the course on design thinking enables you to broaden your strategic perspective, find novel opportunities for innovation, and keep your business moving forward.

**Pre-requisites:**

NIL

**Course Objectives:**

- To provide knowledge on the concepts of Design Thinking
- To impart knowledge on the phases of Design Thinking
- To apply Design Thinking concepts

**Course Outcomes:**

Learner will be able to:

1. Understand the concepts of design thinking approaches
2. Create design thinking teams and conduct design thinking sessions
3. Apply both critical thinking and design thinking in parallel to solve problems
4. Apply design concept to their daily work

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Tutorial	Theory	Tutorial
2	1	2	1

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory + Tutorial	40	20	40	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of

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the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Design Thinking Overview	What is different about design thinking, Design thinking skills, Design thinking mindset, Principles of Design thinking	2
2	General Approaches to Design Thinking	The basics of Design thinking, Design thinking frameworks, Design thinking team, Design thinking workshops and meeting – Characteristics and types	4
3	Design Thinking approach in stages	Apply design thinking framework, emphasize with customers/users, Define the problem, Ideate, Prototype, Test solution.	7
4	Design Thinking Techniques	Listening and emphasizing techniques – Engagement, Observation, showing empathy, Define and ideation techniques – Unpacking, Personas, Pattern recognition and connecting the dots, Prototype, and testing techniques – Types of prototypes, forms of testing in design thinking,	7
5	General Design Thinking Practices	Use of diagrams and maps in design thinking – empathy map, affinity diagram, mind map, journey map. Story telling techniques – Improvisation, scenarios, K-scripts	8
6	Adopt and Adapt Design thinking	Cautions and pitfalls – assumptions, pitfalls and cautions in design thinking workgroups, Best practises	2
<b>Total</b>			<b>30</b>

**Reference Books:**

1. Tim Brown "Change by Design - How Design Thinking Transforms Organisations and Inspires Innovations "
2. Larry J.Leifer, Michael Lewerick, and Patrick "The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods"

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**Course Name:** Indian Constitution

**Course Code:** GEPS01

**Category:** General Education (Political Science)

**Preamble:**

This course introduces learners to the framework that demarcates fundamental political code, structure, procedures, powers, and duties of government institutions and sets out fundamental rights, directive principles, and the duties of citizens.

**Pre-requisites:**

NIL

**Course Objective:**

- To Understand what a constitution is and why it is necessary
- To Understand how constitution embodies certain ideals
- To understand the importance of fundamental rights as well as fundamental duties.
- To understand functioning of parliament

**Course Outcomes:**

Learner will be able to:

CO1: learner will be able to understand constitution principles

CO2: learner will be able to co-relate with political system

CO3: learner will be able to pursue the values of civic life

CO4: learner will be able to exercise their rights and duties

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Introduction	Historical background of constitution, Philosophy of constitution	3
		Citizenship at the commencement of the Constitution, Rights of citizenship of certain persons of Indian origin residing outside India, Persons voluntarily acquiring citizenship of a foreign State not to be citizens, Continuance of the rights of citizenship, Fundamental Duties	4
3	Fundamental Rights	Definition, Laws inconsistent with or in derogation of the fundamental rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Core issues (Uniform civil code, Article 370, Reservation)	4
4	Directive Principles of State Policy	Definition, Certain principles of policy to be followed by the State, Equal justice and free legal aid, Organisation of village panchayat, Right to work, to education and 10 public assistance in certain cases, Provision for just and humane conditions of work and maternity relief, Living wage, etc., for workers, Participation of worker; in management of industries, Uniform civil code for the citizens, Provision for free and compulsory education for children, Promotion of educational and economic interests of Scheduled Castes, Scheduled Tribes and other weaker sections, Protection and improvement of environment and safeguarding of forests and wild life, Protection of monuments and places and objects of national importance, Separation of judiciary from executive, Promotion of international peace and security	4
5	The Parliament	Constitution of Parliament, Composition of the Council of States, Composition of the House of the People, Duration of Houses of Parliament, Rights of Ministers and Attorney-General as respects Houses, Law making procedure, Amendment process and language	4
6	Judiciary	Establishment and Constitution of Supreme Court, High Courts for States, Subordinate Courts, Working of quasi – judicial bodies	4
7	Elections	Superintendence, direction and control of elections to be vested in an Election Commission, Power of Parliament to make provision with respect to elections to Legislatures, Power of Legislature of a State to make provision with respect to elections to such Legislature Bar to interference by Courts in electoral matters	4



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8	Landmark cases	Nanavati case, Shah Bano, Keshvanand Bharti, Vishakha Case etc	3
<b>Total</b>			<b>30</b>

**Suggested Online Courses:**

1. Constitutional Studies  
[https://onlinecourses.nptel.ac.in/noc20\\_lw03/preview](https://onlinecourses.nptel.ac.in/noc20_lw03/preview)
2. Constitution of India  
<https://www.udemy.com/course/constitution-of-india/>

**Reference Books:**

1. D.C. Gupta – Indian Government and Politics
2. D.D. Basu – Introduction to the Constitution of India
3. P. M. Bakshi - The Constitution of India
4. M. V. Pylee - Constitutional History of India

**Course Name:** Universal Human Values

**Course Code:** GESB02

**Category:** General Education (Social and Behavioral Science)

**Preamble:**

The present education system has become largely skill-based. The prime emphasis is on science and technology. However, science and technology can only help to provide the means to achieve what is considered valuable in terms of facilities. Value Education is a crucial missing link in the present education system. Because of this deficiency, most of our efforts may prove to be counterproductive and serious crises at the individual, societal and environmental level are manifesting.

Values and skill complement each other. Values mean importance or participation and skills mean qualities, training, and capabilities. To fulfil our aspirations both values and skills are necessary. When we identify and set the right goals and produce in right direction, this is known as value domain, the domain of wisdom. Basically we must know what really is useful to achieve human happiness, the happiness to all and for all the time.

And when we learn and practices to actualize this goal to develop the techniques to make this happen in real life, in various dimensions of human Endeavour, this is known as domain of skills. Hence, there is an essential bonding between values and skills for the success of any human endeavour.

For a happy and successful life it is important to know, explore, verify and practice universal human values, professional ethics.

**Course Objectives:**

- To help the student to see the need for developing a holistic perspective of life.
- To sensitize the student about the scope of life – individual, family, society and nature/existence.
- Strengthening self-reflection.
- To develop more confidence and commitment to understand, learn and act accordingly.

**Course Outcomes:**

Learner will be able to:

CO1: Learner will become more aware of themselves and their surroundings.

CO2: Learners will be more responsible in life and will able to handle critical problems.

CO3: Learners will develop better critical ability.

CO4: Learners will be more sensible towards commitment.

CO5: Learner will be able to apply human values in day to day life.

CO6: Learner will become a responsible citizen..

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**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Introduction to Value Education	Need for Value Education, Basic Guidelines for Value Education, The Content of Value Education, The Process of Value Education, Starting to observe inside What is Self-exploration? What is its Purpose? Content of Self-exploration, Process of Self-exploration Natural Acceptance, What is the State today? What is the way out? What do we need to do?	5
2	The Basic Human Aspirations Continuous Happiness and Prosperity	Continuous Happiness and Prosperity Our Basic Aspirations Exploring Happiness and Prosperity A Look at the Prevailing Notions of Happiness and Prosperity, Some Possible Questions/Confusions Basic Requirements for Fulfilment of Human Aspirations What is our State today?, Why are we in this State? - Living with Wrong Assumptions, What is the Solution? The Need for Right Understanding Our Program: Understand and Live in Harmony at all Levels of Living , Our State today Our Natural Acceptance for Harmony at all Levels of our Living , Human and Animal Consciousness	5
3	Understanding the Human Being as Co-existence of Self ('I') and Body	Human Being is more than just the Body Understanding Myself as Co-existence of the Self and the Body ,Understanding Needs of the Self and Needs of the Body, Understanding the Activities in the Self and the Activities in the Body, Understanding the Self (I) as the Conscious Entity, the Body as the Material Entity Exercise on distinguishing Needs of the Self ('I') and Body	5

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Module No.	Module Name	Content	No. of Hours
		<p>Exercise on Distinguishing Activities of the Self (I) and Body Understanding the Body as an Instrument of 'I' ('I' being the Seer, Doer and Enjoyer) Why should I study Myself?, Getting to know the Activities in the Self (I) How are the Activities in T Related! The Activities in 'I' are Continuous Effects of the Problem... What then is the Solution? Result of Realization and Understanding Living with Definiteness Our Body A Self-organized Unit Harmony of T with the Body: Sanyama and Svasthya What is our State today? What is the way out? Understanding and Living with Sayama Correct Appraisal of our physical needs</p>	
4	Harmony in the Family, Society,Nature-Understanding Values in Human Relationships	<p>Family as the Basic Unit of Human Interaction, Harmony in the Family.Justice (Nyaya),What is the State today? Values in Human Relationships,Trust (Visvasa) Respect (Sammāna) The Basis for Respect Assumed Bases for Respect Today The Problems due to Differentiation Difference between Attention' and 'Respect' What is the way out? Affection (Sneha) Care (Mamand) Guidance (Vatsalya) Reverence (Shraddha) Glory (Gaurava) Gratitude (Kritagayta) Love (Prema) Harmony from Family to World Family: Undivided Society Extending Relationship from Family to Society Identification of the Comprehensive Human Goal Where are we today? Programs Needed to Achieve the Comprehensive Human Goal: The Five Dimensions of Human Endeavour Education-Right Living (Siksha Sanskara) Health-Self-regulation (Svasthya-Sanyama) Justice-Preservation (Nyaya-Suraksha) Production-Work (Utpadana-Karya) Exchange-Storage (Vinimaya-Kosa) What is our State today? Harmony from Family Order to World Family Order: Universal Human Order The Four Orders in Nature Interconnectedness and Mutual Fulfilment (Parasparta aur Paraspara Purakata) Recyclability and Self-regulation in Nature Undertanding the Four Orders Things (Vastu) Activity (Kriya)</p>	5

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Module No.	Module Name	Content	No. of Hours
		Innateness (Dharana) Natural Characteristic (Sabha) ,Basic Activity,Conformance Human Beings-our State today What is way out	
5	Implications of the Right Understanding	Values in Different Dimensions of Human Living Universal Values naturally emerging from the Right Understanding Definitiveness of Ethical Human Conduct Identification of Snama leading to Svatantrata and Swarajya Development of Human Consciousness Implications of Value-based Living Identification of Comprehensive Human Goal Vision for the Holistic Alternative Basis for Humanistic Education and Humanistic Constitution Universal Human Order and its Implications	5
6	Professional Ethics Journey towards the Holistic Alternative	Profession-In the Light of Comprehensive Human Goal Ensuring Competence in Professional Ethics- The current Scenario Inherent Contradictions and Dilemmas and their Resolution Appreciating the Need for Self-Exploration Facilitating the Understanding of Harmony at various Levels Steps for Evolution at the Individual Level Steps for Transition at the Level of Family Society and Profession Promoting Mass Awareness and moving towards Humanistic Education Evolving Holistic Models of Living Amending Policies, Programs and Social Systems in tune with Comprehensive Human Goal Is the Transition too Difficult? Concluding Remarks	5
<b>Total</b>			<b>30</b>

**Reference Books:**

1. A Foundation course in Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria Excel books.

**Course Name:** Indian Traditional Knowledge System

**Course Code:** GESB03

**Category:** General Education (Social and Behavioral Science)

**Preamble:**

India has a vast tradition of Sanskrit texts dealing with various scientific thoughts. Number of treatises on the topics like Agriculture, Animal Husbandry, Chemistry, Astronomy, Mathematics, Botany, etc. focus on the development of thoughts in the concerned area.

This course aims at introducing a student with various treatises on physical as well as social sciences and their contribution to modern branches of sciences. Taking into consideration the vast scope of these sciences, major treatises will be introduced in the course thereby making a student to ponder over the ancient knowledge systems of India.

**Pre-requisites:**

NIL

**Course Outcomes:**

- To facilitate the learners with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
- It aims at imparting basic principles of thought process, reasoning and inference

**Course Outcomes:**

Learner will be able to:

CO1: Understand and the rich history of Indian knowledge system

CO2: Understand the different areas of contribution from India.

CO3: Apply the different principals of traditional knowledge in modern systems.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

Module No.	Module Name	Content	No. of Hours
1	Review of Scientific Literature in Sanskrit	References of sciences/scientific knowledge through different textual sources etc.	6
2	Chemistry and Mathematics	Various treatises on Chemistry, Use of chemistry in medicines, Metallurgy, Use of chemistry for occult practices, Mathematical concepts through Shulbasutras, Development of different mathematical branches and treatises based on that, Development of astronomy, etc.	15
3	Dietetics	Study of different texts based on culinary art Nalapakadarpana, Bhojanakutuhalam, Supashastra, Modes of preservation of food, Dietary guidelines through branches of Ayurveda, Food and diseases, etc.	5
4	Agriculture, Astronomy, and Zoology	Study of krishisuktas, Krishiparashara, Brihatsamhita, Types of crops, Manures, Types of land- devamatraka, nadimatraka, Indian Astronomy, Use of animals in warfare, Animal husbandry, Animals for medicines, etc.	4
<b>Total</b>			<b>30</b>

**Reference Books:**

1. Nirmal Trikha "Scientific Knowledge in Sanskrit Literature"
2. S. Balachandra Rao "Indian Astronomy: An Introduction"
3. B. Seal "Ancient Indian Sciences"
4. Melissa Stewart "Science in Ancient India (Science of the Past)"
5. India's Contribution to World Culture – SudheerBirodkar
6. Ancient India – R. C. Majumdar
7. Ancient Indian Sciences – Swami ChidatmanJee Maharaj
8. Nalini sadhale, H. V. Balkundi and Y.L.Nene "KrishiParashara – Agriculture by Parashara " Asian Agri-History Foundation
9. Stella Kramrisch "The Art of India through the Ages"
10. K.Krishna Murthy "Early Indian Secular Architecture"
11. Raman Sukumar "The Asian Elephant: Ecology and Management" Cambridge University Press

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**Course Name:** Voice Culture for Professional Speaking

**Course Code:** GEA01

**Category:** General Education (Arts)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development. These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Improve their oratory skills when they step out in the corporate world as competent professionals.

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.



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**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Voice Culture for Professional Speaking	Introduction to Voice, Do's and don'ts for voice, General Reading session, Review of reading session. Good posture exercise, Relaxing the mind exercise, Tongue stretching exercise, breathing exercise or good fuller voice. Resonance, Improving resonance, voice clarity exercise, accent. Reading session – voice projection, understanding personality – traits, emotions, body language. Nonverbal communication, Thoughts – positive, negative and their effect on voice. Listening skill and exercise. Voice modulation, pitch, volume, tone, stress, speed, rhythm. Pronunciation – The Indian accent way, Presentation skills	12
<b>Total</b>			<b>12</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

**Course Name:** Financial Management for Beginners

**Course Code:** GEF02

**Category:** General Education (Finance)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Take financial decisions wisely from early stage of earning

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

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**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Financial Management for Beginners	Overview of Economics, macroeconomics, microeconomics, Money and its flow Overview of Share Market, Primary market, secondary market, nature of trading, scrips for short term and long-term investment Modes of Investments, Debt, equity, gold, property, assessment of investment type. Mutual Funds, Fund houses, mutual fund schemes, SIP, Magic of compounding Crypto and its future, maximum asset allocation in crypto Growing sectors from Engineering perspective	10
<b>Total</b>			<b>10</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

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**Course Name:** Four Pillars of Democratic Nation

**Course Code:** GEPS02

**Category:** General Education (Political Science)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Understand how they can contribute towards each pillar of democracy.

CO2: Work towards developing holistic personality through critical and creative thinking.

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

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**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Four Pillars of Democratic Nation	The term 'Democracy', History of democracy, Indian Democracy, Responsibility of good citizen. Legislature – Six major functions of legislature Executive - President, Vice-President, Prime Minister, Cabinet Minister, Secretaries, and Civil services Judiciary – Indian Juridical system, Indian Constitution, Court structure Media - The basic right of freedom of speech and expression, Print Media and digital media	08
<b>Total</b>			<b>08</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

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**Course Name:** Railways – Wonders of Infrastructure

**Course Code:** GEWI01

**Category:** General Education (Wonders of Infrastructure)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Understand reach of Indian Railways and how can engineers contribute towards it

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

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**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Railways – Wonders of Infrastructure	History of civilization, Industrial revolution, early-stage steam engine, steam powered locomotives Liverpool to Manchester railways, Economic changes brought by railways. Indian Railways, Land and bridges, electrification, telecommunication, public sector undertakings, Reforms in railway sector.	06
<b>Total</b>			<b>06</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

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**Course Name:** IQ vs EQ

**Course Code:** GEPEW02

**Category:** General Education (Physical Education and Wellness)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development. These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Understand strategies to enhance EQ as it is important in their personal as well as professional success.

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.



Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	IQ vs EQ	Introduction to Emotional Intelligence, the ability to understand, use, and manage your own emotions in positive ways to relieve stress, communicate effectively, empathize with others, overcome challenges and defuse conflict. Applications of EQ skills for mental health and wellbeing, self-awareness, self-motivation, active listening. The EQ view and Neuroscience of emotional intelligence, Intrinsic motivation and goal setting	08
<b>Total</b>			<b>08</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Course Name:** Facets of Astronomy

**Course Code:** GENS01

**Category:** General Education (Natural Science)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Develop an urge to research things that occur naturally on earth and in the universe.

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Facets of Astronomy	Astrophysics: applying the laws of physics in space. Astrometry: mapping celestial bodies. Astrogeology: examining rocks, terrain, and material in space. Astrobiology: Searching for life outside Earth. Use of physics, mathematics, chemistry in astronomy Types of telescopes, Refractor Telescopes. Reflector Telescopes. Dobsonian Telescopes. Maksutov-Cassegrain Telescopes. The scientific study of celestial objects visible at night, Various celestial objects to observe.	05
<b>Total</b>			<b>05</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Course Name:** Various Dance Forms

**Course Code:** GEA02

**Category:** General Education (Arts)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development. These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Differentiate between various dance forms

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
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**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Various Dance Forms	Dance, Definition, History, music, rhythm. Basic understanding of the term ABHINAYA and definition of its four aspects. Technical terminology of dance. Acquaintance with the traditional costumes. Dance forms: Indian Classical dance, folk dance, Bollywood, Jazz and performances	08
<b>Total</b>			<b>08</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Course Name:** Responsibility towards Sustainable Environment

**Course Code:** GESB06

**Category:** General Education (Social and Behavioral Science)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Sensitize himself towards the need for promoting sustainable environment practices

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning.

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Responsibility towards Sustainable Environment	Sustainability, Pillars of sustainability, social equity, economic development, environmental protection, cultural/human sustainability. Sustainable development, United nation's sustainable development goals. Sustainable Environment, long term health of ecosystem, renewable resources, Global warming, protection of species diversity and ecological structure, Low carbon economy. Being responsible towards sustainable environment, dos and don'ts, Smart City – city functions, economic growth, quality of life, technology used.	06
<b>Total</b>			<b>06</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Course Name:** Nutrition and Physical Wellness

**Course Code:** GEPEW03

**Category:** General Education (Physical Education and Wellness)

**Preamble:**

Wide platter of General Education courses are offered to First Year Engineering students with an aim to focus on holistic personality development These courses will also help to create balance in brain hemispheres and thereby improve learners' clarity in thoughts and responses.

**Pre-requisites:**

NIL

**Course Objectives:**

- To develop the intellectual skills and competencies necessary to participate effectively in society and the world
- To develop broad knowledge of living and non-living world
- To develop ability to integrate knowledge, make informed ethical decisions and accept civic responsibilities

**Course Outcomes:**

Learner will be able to:

CO1: Adapt healthy lifestyle and focus on overall wellbeing

CO2: Work towards developing holistic personality through critical and creative thinking

CO3: Complement technical knowledge by developing diversified perspectives on various aspects of learning

**Course Scheme:**

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

**Assessment Guidelines:**

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	50	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.



Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**Detailed Syllabus:**

<b>Module No.</b>	<b>Module Name</b>	<b>Content</b>	<b>No. of Hours</b>
1	Nutrition and Physical Wellness	Nutrition, Types of nutrition, Human need, Carbohydrates, proteins, vitamins, water, fats, minerals Well-balanced diet and its advantages Physical activities, daily exercises, need of stretching in working hours, best time and duration for physical activities, risk of taking supplements, dangers of following harmful fads. Physical wellness, finding time to move your body, warning sign by body, maintaining regular sleep schedule, maintaining ideal weight.	08
<b>Total</b>			<b>08</b>

**Recommended Online Courses:**

Nil

**Reference Books:**

As suggested by resource person in session

**Appendix-A**  
**General Education Sub-Categories**

GE Sub-Category	GE Sub-Category Code
Arts	A
Social and Behavioral Science	SB
Creativity and Innovation	CI
Political Science	PS
Physical Education and Wellness	PEW
Finance	F
Natural Science	NS
Wonders of Infrastructure	WI

**Courses under General Education (GE) Category**

Course Code	Course Name	Credits
GEA01	Voice Culture for Professional Speaking	2
GEA02	Various Dance Forms	2
GEA03	Exploring Indian Art	2
GESB01#	Social Service Internship/ Project	3
GESB02	Universal Human Values	2
GESB03	Indian Traditional Knowledge System	2
GESB04	Corporate and Social Etiquettes	2
GESB05	Global Citizenship Education	2
GESB06	Responsibility towards sustainable environment	2
GESB07	Psychology	2
GECI01	Design Thinking	2
GECI02	Innovation and Entrepreneurship	1
GEPS01	Indian Constitution	2
GEPS02	Four Pillars of Democratic Nation	2
GEPEW01	Wellness – Body, Mind & Spirit	2
GEPEW02	IQ vs EQ	2
GEPEW03	Nutrition and Physical Wellness	2
GEF01	Basics of Finance & Legal aspects for Business	2
GEF02	Financial Management for beginners	2
GENS01	Facets of Astronomy	2
GENS02	Modern Farming	2
GEWI01	Railways - Wonders of Infrastructure	2
GE01\$	Internship with other Institutes (Credit Transfer)	4

Programme Scheme and Syllabus(2022) for First Year Bachelor of Technology (B.Tech.)  
Biomedical Engineering

**# For GEB01- Social Service Internship/ Project:** 2 hours / week slot will be provided during the semester (in regular timetable). Additional work of 60 hours needs to be completed during the semester (besides regular timetable) or after the semester (during inter semester break).

**\$ GE01- Internship with other Institutes (Credit Transfer):** Internship with other reputed institutes equivalent to 4 credits is recommended to be done by learner during second year inter semester break(i.e. summer break between semester 4 and semester 5)

**(Draft Copy of Programme Scheme and Syllabus(R-2022) Subject to approval of Academic Council, Vidyalankar Institute of Technology)**



# **Vidyalankar Institute of Technology**

*(Autonomous Institute Affiliated to the University of Mumbai)*

## **Scheme and Detailed Syllabus**

**of**

**Second Year**

**in**

**Bachelor of Engineering**

**in**

**Biomedical Engineering**

(Curriculum of REV- 2019 'C' Scheme of UoM)

With effect from Academic Year 2022-23

**Program Structure for Second Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**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 <sup>\$</sup>	--	--	2	--	2
<b>Total</b>		<b>16</b>	<b>14</b>	<b>1</b>	<b>16</b>	<b>07</b>	<b>1</b>	<b>24</b>

**Evaluation Scheme for Second Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester III**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC301	Engineering Mathematics - III	25	40	60	125
BMC302	Human Anatomy and Physiology for Engineers	20	30	50	100
BMC303	Medical Sensors	20	30	50	100
BMC304	Electronic Circuits Analysis and Design	20	30	50	100
BMC305	Digital Electronics	20	30	50	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
<b>Total</b>		<b>250</b>	<b>150</b>	<b>325</b>	<b>725</b>

Total Contact Hours/week :31

Total Credit : 24

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

**Program Structure for Second Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**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 <sup>\$</sup>	--	--	2	--	2
<b>Total</b>		<b>15</b>	<b>14</b>	<b>1</b>	<b>15</b>	<b>7</b>	<b>1</b>	<b>23</b>

**Evaluation Scheme for Second Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester IV**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC401	Engineering Mathematics - IV	25	40	60	125
BMC402	Integrated Circuit Design	20	30	50	100
BMC403	Principles of Control Systems	20	30	50	100
BMC404	Medical Imaging – I	20	30	50	100
BMC405	Biomaterials and Artificial Organs	20	30	50	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
<b>Total</b>		<b>250</b>	<b>150</b>	<b>350</b>	<b>750</b>

Total Contact Hours/week : 30

Total Credit :23

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination



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

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC301	Engineering Mathematics - III	25	40	60	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
<b>BMC301</b>	<b>Engineering Mathematics - III</b>	<b>04</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.</li> <li>To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills</li> <li>To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane.</li> <li>To understand the basics of Linear Algebra and its applications</li> <li>To use concepts of vector calculus to analyze and model engineering problems.</li> </ul>	
<b>Course Outcomes</b>	<p>On successful completion of course learner will be able to:</p> <ul style="list-style-type: none"> <li>Apply the concept of Laplace transform to solve the real integrals in engineering problems.</li> <li>Apply the concept of inverse Laplace transform of various functions in engineering problems.</li> <li>Expand the periodic function by using Fourier series for real life problems and complex engineering problems.</li> <li>Find orthogonal trajectories and analytic function by using basic concepts of complex variables.</li> <li>Illustrate the use of matrix algebra to solve the engineering problems.</li> <li>Apply the concepts of vector calculus in real life problems.</li> </ul>	

Module	Detailed Contents	Hrs.
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01	<p><b>Module: Laplace Transform</b></p> <p>1.1 Definition of Laplace transform, Condition of Existence of Laplace Transform.  1.2 Laplace Transform (L) of standard functions like <math>e^{at}</math>, <math>\sin(at)</math>, <math>\cos(at)</math>, <math>\sinh(at)</math>, <math>\cosh(at)</math> and <math>t^n, n \geq 0</math>.  1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale Property, Multiplication by <math>t</math>, Division by <math>t</math>, Laplace Transform of derivatives and integrals (Properties without proof).  1.4 Evaluation of integrals by using Laplace Transformation.</p> <p><b>Self-learning Topics:</b> Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.</p>	7
02	<p><b>Module: Inverse Laplace Transform</b></p> <p>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).</p> <p><b>Self-learning Topics:</b> Applications to solve initial and boundary value problems involving ordinary differential equations.</p>	6
03	<p><b>Module: Fourier Series:</b></p> <p>3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).  3.2 Fourier series of periodic function with period <math>2\pi</math> and <math>2l</math>.  3.3 Fourier series of even and odd functions.  3.4 Half range Sine and Cosine Series.</p> <p><b>Self-learning Topics:</b> Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.</p>	7
04	<p><b>Module: Complex Variables:</b></p> <p>4.1 Function <math>f(z)</math> of complex variable, limit, continuity and differentiability of <math>f(z)</math> Analytic function, necessary and sufficient conditions for <math>f(z)</math> to be analytic (without proof).  4.2 Cauchy-Riemann equations in cartesian coordinates (without proof).  4.3 Milne-Thomson method to determine analytic function <math>f(z)</math> when real part (<math>u</math>) or Imaginary part (<math>v</math>) or its combination (<math>u+v</math> or <math>u-v</math>) is given.  4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories.</p> <p><b>Self-learning Topics:</b> Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.</p>	7
05	<p><b>Module: Linear Algebra: Matrix Theory</b></p> <p>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.</p> <p><b>Self-learning Topics:</b> Application of Matrix Theory in machine learning and google pagerank algorithms, derogatory and non-derogatory matrices.</p>	6
06	<p><b>Module: Vector Differentiation and Integral</b></p> <p>6.1 <b>Vector differentiation:</b> Basics of Gradient, Divergence and Curl (Without</p>	6

	Proof). <b>6.2 Properties of vector field:</b> Solenoidal and Irrotational (conservative) vectorfields. <b>6.3 Vector integral:</b> Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation.  <b>Self-learning Topics:</b> Gauss' divergence Theorem and applications of Vector calculus.	
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#### 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

#### In Semester Assessment (ISA):

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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC302	Human Anatomy and Physiology for Engineers	3		--	3		--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC302	Human Anatomy and Physiology for Engineers	20	30	50	100

Course Code	Course Name	Credits
<b>BMC302</b>	<b>Human Anatomy and Physiology for Engineers</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the anatomical structures of the human body and their relationship to each other.</li> <li>To understand the different physiological processes taking place inside the human body.</li> </ul>	
<b>Course Outcomes</b>	Learners will be able to: <ul style="list-style-type: none"> <li>Explain the organization of the human body, homeostasis and its maintenance, structure and functions of a cell and basic tissues.</li> <li>Explain the components of blood and their functions.</li> <li>Explain the anatomical parts and physiological processes of the cardiovascular system and respiratory system.</li> <li>Explain the anatomical parts and physiological processes of the alimentary system and renal system.</li> <li>Explain the structure and functions of nervous system, eye and skin along with the secretions and functions of all endocrine glands.</li> </ul>	

Module	Contents	Hours
<b>1.</b>	<p><b>Introduction to the Human Body:</b> Levels of structural organization; Characteristics of living human organism; Homeostasis and its maintenance.</p> <p><b>Cells and Tissues:</b> Structure and functions of a cell; Transport across the plasma membrane; membrane potentials; Tissues: epithelial, connective, muscle and nervous.</p>	<b>04</b>
<b>2.</b>	<p><b>Cardiovascular System:</b> 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.</p> <p><b>Respiratory System:</b> Anatomy of respiratory system; Pulmonary ventilation, lung volumes and capacities; Gas laws - Dalton's law and Henry's law, external respiration, internal respiration.</p>	<b>10</b>
<b>3.</b>	<p><b>Blood:</b> Composition of Blood, blood cells and their functions, haemoglobin; Blood Grouping; Haemostasis.</p>	<b>04</b>

4.	<p><b>Alimentary System:</b> Anatomy of the alimentary system; Secretions of different organs of the alimentary system and their main functions.</p> <p><b>Renal System:</b> Anatomy of the renal system; Functions of kidney (urine formation, electrolyte balance and <i>pH</i> balance); composition of urine; Micturition.</p>	<b>10</b>
5.	<p><b>Nervous System:</b> 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.</p>	<b>05</b>
6.	<p><b>Special Senses:</b> Structure of the eye; Physiology of vision; Structure and functions of the skin.</p> <p><b>Endocrine System:</b> All Glands of the endocrine system, their secretions and functions.</p>	<b>06</b>

### 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](https://swayam.gov.in/nd1_noc20_bt42/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC303	Medical Sensors	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC303	Medical Sensors	20	30	50	100

Course Code	Course Name	Credits
<b>BMC303</b>	<b>Medical Sensors</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To provide the knowledge of basic concepts such as generalized medical instrumentation system, input transducer properties, and instrument characteristics.</li> <li>• 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.</li> <li>• To study the medical applications of the above transducers and sensors.</li> <li>• To perform experiments based on some of the above transducers and sensors.</li> </ul>	
<b>Course Outcomes</b>	<p>The learner will be able to :</p> <ul style="list-style-type: none"> <li>• Explain different components of a generalized medical instrumentation system, input transducer properties, and instrument characteristics.</li> <li>• Apply the knowledge of principles of various types of transducers and sensors including motion, displacement, force, pressure sensors to different medical applications.</li> <li>• Apply the knowledge of principles of various types of temperature sensors to different medical applications.</li> <li>• Apply the knowledge of the various biopotential electrodes for measuring different types of biopotentials.</li> <li>• Apply the principles of various chemical sensors for measuring concentration of biochemical analytes.</li> <li>• Explain the principles of various biosensors and their medical applications.</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction:</b> 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.	<b>Displacement, Motion, Force and Pressure Sensors and their Medical Applications:</b> 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.	<b>Temperature Sensors and their Medical Applications:</b> Temperature measurement: Thermistor, thermocouple, resistive temperature detector; IC-based temperature measurement; Radiation sensors: Thermal sensors, quantum sensors, and radiation thermometry.	06
4.	<b>Biopotential electrodes:</b> 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.	<b>Chemical Sensors and their Medical Applications:</b> Blood gas and acid- base physiology; pH, Pco <sub>2</sub> , Po <sub>2</sub> electrodes; ISFETs; Transcutaneous arterial O <sub>2</sub> and CO <sub>2</sub> tension monitoring. <b>Fiber optic Sensors and their Medical Applications:</b> Principle of fiber optics; Fiber optic sensor types - Temperature, chemical, and pressure.	07
6.	<b>Biosensors:</b> 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, Banshi 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, Merrill Publishing Company.
4. Measurement Systems, Application and Design, Ernest O. Doebelin, 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, JohnWiley & Sons.

**NPTEL/Swayam Course:**

Course: Industrial Instrumentation by Prof. Alok Barua - IIT Kharagpur

<https://nptel.ac.in/courses/108/105/108105064/>



Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC304	Electronic Circuits Analysis and Design	4	--	--	4	--	--	4

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC304	Electronic Circuits Analysis and Design	20	30	50	100

Course Code	Course Name	Credits
<b>BMC304</b>	<b>Electronic Circuit Analysis and Design</b>	<b>04</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand transfer characteristics of semiconductor devices and to analyse basic application circuits.</li> <li>To make learners aware about the mathematical models of BJT and its use in analysing the circuits.</li> <li>To make the learners aware about different types of coupling and the concept of multistage amplifiers.</li> <li>Learners will be able to design power amplifier.</li> <li>To learn types and applications of MOSFET.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Explain the transfer characteristics in analysing the electronic circuits which use diode, BJT etc.</li> <li>Explain equivalent circuits of BJT and apply them to analyse and design BJT based amplifier circuits</li> <li>Apply the knowledge of mathematical model to analyse multistage amplifiers.</li> <li>Design and analyse power amplifiers.</li> <li>Apply the concept of transfer characteristics, D.C. load line, A.C. load line to analyse MOSFET amplifiers.</li> </ul>	

Module	Contents	Hours
1.	<b>Basics of Diodes:</b> Construction, Working, Characteristics, Current Equation & Equivalent circuits of P-N Junction Diode as well as Zener Diode; Applications of Diode: Clipper & Clamper.	06
2.	<b>Basics &amp; DC analysis of BJT:</b> 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.	<b>BJT as an Amplifier:</b> A.C. Equivalent Model: $r_e$ model, h-parameter model (Exact and Approximate) and Hybrid- $\pi$ 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.	<b>Multistage Amplifier:</b> Need of cascading; Types of coupling; D.C. and A.C. analysis of CS-CE cascade configuration, Cascode amplifier, Darlington amplifier.	08
5.	<b>Power Amplifiers:</b> 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.	<b>MOSFET:</b> Comparison of BJT & FET, Classification, Characteristics, Biasing of MOSFET, MOSFET as an amplifier & MOSFET as a switch.	10

#### Books Recommended:

#### Textbooks:

1. Electronics Circuit. Analysis & Design, 2<sup>nd</sup> ed., Donald A. Neamen, McGraw Hill, 2001
2. Electronics Devices & Circuits Theory, by Robert L. Boylestad and Louis Nashelsky, Pearson Education.
3. Semiconductor Data Manual, BPB Publications.

#### Reference Books:

1. Electronic Principles, by Albert Paul Malvino 6<sup>th</sup> 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/>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC305	Digital Electronics	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC305	Digital Electronics	20	30	50	100

Course Code	Course Name	Credits
<b>BMC305</b>	<b>Digital Electronics</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops.</li> <li>Learner should be able to design various counters, registers and know their applications.</li> <li>Learner should be able to design sequential circuits as a state machine.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Describe various number systems, logic gates and logic families.</li> <li>Apply Boolean algebra, K-maps for Logic reduction and implementations in SOP and POS form</li> <li>Develop combinational circuits such as code converter circuits, parity generator checker circuits and magnitude comparator circuits. Also, circuits using multiplexers, de-multiplexers, and decoders.</li> <li>Design synchronous sequential circuits and asynchronous counters using flip flops</li> <li>Design various registers using flip flops.</li> </ul>	

Module	Contents	Hours
1.	<p><b>Fundamentals of Digital Design:</b></p> <p><b>Introduction:</b> Number system: Binary, Octal, Hexadecimal and other. Conversion from One system to another.</p> <p><b>Binary Codes:</b> Weighted, Reflective, Sequential, Gray, Error detecting codes, Odd, Even parity, Hamming Codes etc.</p> <p><b>Logic Gates and Families:</b> AND, OR, NOT, XOR, XNOR, operation NAND, NOR used of the universal gate for performing different operations. TTL and CMOS logic families.</p>	04
2.	<p><b>Combinational Logic Design:</b></p> <p><b>Boolean Algebra:</b> Laws of Boolean algebra, De- Morgan's theorems, Relating a Truth Table to a Boolean Expression, Multilevel circuits.</p> <p><b>Logic Reduction Techniques:</b> K-MAPS and their use in specifying Boolean Expressions, Prime-implicant, Minterm, Maxterm, SOP and POS Implementation. Implementation of logic function using universal gates.</p> <p>Application of gray code, Hazards in combinational circuits.</p>	08
3.	<p><b>MSI Combinational Circuits:</b></p> <p><b>Elementary Designs:</b> Designing code converter circuits e.g. Binary to Gray, BCD to Seven Segments, Parity Generator and Parity Checker (3 bit).</p> <p><b>Binary Arithmetic Circuits:</b> Binary Addition, Binary Subtraction (ones and twos complement), (Half &amp; Full) Adders, (Half &amp; Full) Subtractors, BCD adder, BCD-Subtractor (9's complement method), Serial adder, Multiplier, Magnitude Comparators, 7485 comparator, Arithmetic Logic Units.</p> <p><b>Use of Multiplexers in Logic Design:</b> Multiplexer (ULM) Shannon's theorem. De-Multiplexers, Line decoders.</p>	11
4.	<p><b>Fundamentals of Sequential Logic Circuits:</b></p> <p><b>Flip-Flops:</b> Comparison of Combinational &amp; Sequential Circuits, Flip-Flops, SR, T,D, JK, Master Slave JK, Converting one Flip-Flop to another</p> <p><b>Counters:</b> Modulus of a counter, Designing of synchronous and asynchronous counter using flip flop, Concept of drawing state transition diagram &amp; state transition table. Minimum cost and minimum risk approach in design.</p>	08
5.	<p><b>Sequential Circuit Designs:</b> State machine analysis, State machine design as Mealy and Moore machines, basic design of sequence detector.</p>	04
6.	<p><b>Sequential Logic Designs:</b></p> <p><b>Registers:</b> 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.</p>	04

### 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 Yarbrough 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, 2<sup>nd</sup> 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](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](https://swayam.gov.in/nd1_noc20_cs67/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML301	Human Anatomy and Physiology for Engineers Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML301	Human Anatomy and Physiology for Engineers Lab	25			25

Course Code	Course Name	Credits
<b>BML301</b>	<b>Human Anatomy and Physiology for Engineers</b>	<b>01</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the anatomical structures of the human body and their relationship to each other.</li> <li>To gain the knowledge of measurement of various physiological parameters of the human body.</li> </ul>	
<b>Course Outcome</b>	<p>The learner will be able to :</p> <ul style="list-style-type: none"> <li>Demonstrate measurement of blood pressure using occlusive cuff method.</li> <li>Apply blood cell counting principles for measuring blood composition.</li> <li>Demonstrate the measurement of electrical activity of heart and the related parameters.</li> <li>Demonstrate the measurement of various lung volumes and capacities.</li> <li>Appropriately utilize laboratory equipment, such as microscopes, general labware, and virtual simulations.</li> <li>Locate and identify anatomical structures.</li> </ul>	

**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.

### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments. The final certification and acceptance of ISA ensures the satisfactory performance of laboratory 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](https://swayam.gov.in/nd1_noc20_bt42/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML302	Medical Sensors Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML302	Medical Sensors Lab	25		25	50

Course Code	Course Name	Credits
<b>BML302</b>	<b>Medical Sensors</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To analyse the transient response of a first-order system.</li> <li>To measure displacement using various displacement sensors.</li> <li>To measure pressure using a pressure sensor.</li> <li>To measure force using a force sensor.</li> <li>To measure temperature using various temperature sensors.</li> <li>To measure pH of a solution using a pH electrode.</li> </ul>	
<b>Course Outcomes</b>	<p>The learner will be able to:</p> <ul style="list-style-type: none"> <li>Analyse step response of a first-order system.</li> <li>Demonstrate the measurement of displacement using various displacement sensors.</li> <li>Demonstrate the measurement of force and pressure using a force sensor and a pressure sensor respectively.</li> <li>Demonstrate the measurement of temperature using various temperature sensors.</li> <li>Distinguish various biopotential electrodes.</li> <li>Demonstrate the measurement of pH of a solution using a pH electrode.</li> </ul>	

**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 resistor.
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, Merrill Publishing Company.
4. Measurement Systems, Application and Design, Ernest O. Doebelin, 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/>

**In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments. The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork

**Oral examination will be based on suggested practical list and entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML303	Electronic Circuits Analysis and Design Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML303	Electronic Circuits Analysis and Design Lab	25		25	50

Course Code	Course Name	Credits
<b>BML303</b>	<b>Electronic Circuit Analysis and Design Lab</b>	<b>01</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To practically verify characteristics of different electronic components like diodes, BJT, MOSFET etc</li> <li>To practically verify outputs of few applications of diodes, BJT, MOSFET.</li> <li>To design and implement small signal amplifier.</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Explain the transfer characteristics of basic semiconductor devices.</li> <li>Design and verify the outputs of various electronic circuits such as clipper, clampers etc using bread boards and various lab equipments.</li> <li>Design amplifier circuits and plot its frequency response.</li> </ul>	

**Syllabus: Same as that of BMC304 Electronic Circuit Analysis and Design.**

#### List of Laboratory Experiments: (Any Eight)

- To verify semiconductor diode and Zener diode characteristics.
- To implement various clipper circuits and verify output.
- To implement various clamper circuits and verify output.
- To study line regulation and load regulation of voltage regulator using Zener diode.
- To verify input and output characteristics of BJT.
- To implement a switch using BJT.
- To implementation different biasing circuit of BJT
- To design and implement CE amplifier.
- To study frequency response of CE amplifier.
- To verify input and output characteristics of MOSFET.
- To implementation different biasing circuit of MOSFET
- 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.

#### In Semester Assessment (ISA):

ISA shall consist of minimum 8 experiments. The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work

#### Books Recommended:

**Textbooks:**

1. Electronics Circuit. Analysis & Design, 2<sup>nd</sup> ed., Donald A. Neamen, McGraw Hill, 2001
2. Electronics Devices & Circuits Theory, by Robert L. Boylestad and Louis Nashelsky, Pearson Education.
3. Semiconductor Data Manual, BPB Publications.

**Reference Books:**

1. Electronic Principles, by Albert Paul Malvino 6<sup>th</sup> 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 (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML304	Electronics Lab (Skill Based Lab)	--	4	--	--	2	--	2

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML304	Electronics Lab (SBL)	25		25	50

Course Code	Course Name	Credits
<b>BML304</b>	<b>Electronics Lab (Skill Based Lab)</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To design and implement voltage regulator circuits.</li> <li>To design and implement digital circuits.</li> <li>To learn skills of soldering.</li> <li>To learn simulation of circuits using one of the simulation software.</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Design and implement analog and digital electronic circuits on bread board and verify the outputs.</li> <li>Learn one of the tools for simulating different circuits.</li> <li>Know the limitations of ideal environment of simulations and also importance of simulation in designing the circuits.</li> <li>Learn soldering skills for implementing the circuits on PCB.</li> </ul>	

### 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 79XX and/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.

### In Semester Assessment (ISA):

ISA shall consist of minimum 8 experiments from Analog electronics and 8 experiments from digital electronics. The final certification and acceptance of ISA ensures the satisfactory performance of laboratory 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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMM301	Mini Project – 1 A	--	4	--	--	2	--	2

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM301	Mini Project – 1 A	25			25

Course Code	Course Name	Credits
<b>BMM301</b>	<b>Mini Project – 1 A</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>To familiarize the process of solving the problem in a group.</li> <li>To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>To inculcate the process of self-learning and research.</li> </ul>	
<b>Course Outcome</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Identify problems based on societal /research needs.</li> <li>Apply Knowledge and skill to solve societal problems in a group.</li> <li>Develop interpersonal skills to work as member of a group or leader.</li> <li>Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>Use standard norms of engineering practices</li> <li>Excel in written and oral communication.</li> <li>Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>Demonstrate project management principles during project work.</li> </ul>	

### 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:**

#### **In Semester Assessment (ISA):**

- 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

<b>Semester - IV</b>
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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

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC401	Engineering Mathematics - IV	25	40	60	125

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

Course Code	Course Name	Credits
<b>BMC401</b>	<b>Engineering Mathematics – IV</b>	<b>04</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To study the line and contour integrals and expansion of complex valued function in a power series.</li> <li>To understand the basic techniques of statistics for data analysis, Machine learning and AI.</li> <li>To study the probability distributions and expectations.</li> <li>To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems.</li> <li>To familiarize with the concepts of Quadratic forms and Singular value decomposition.</li> <li>To learn the concepts of Calculus of Variations.</li> </ul>	
<b>Course Outcomes</b>	<p>On successful completion of course, learner will be able to:</p> <ul style="list-style-type: none"> <li>Use the concepts of Complex Integration for evaluating integrals, computing residues &amp; evaluate various contour integrals.</li> <li>Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI.</li> <li>Illustrate understanding of the concepts of probability and expectation forgetting the spread of the data and distribution of probabilities.</li> <li>Apply the concept of vector spaces and orthogonalization process in Engineering Problems.</li> <li>Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications.</li> <li>Find the extremals of the functional using the concept of Calculus of variation.</li> </ul>	

Module	Detailed Contents	Hrs.
01	<p><b>Module: Complex Integration</b></p> <p>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 <math>f(z)</math>, Residues, Cauchy's Residue Theorem (without proof).  <b>Self-learning Topics:</b> Application of Residue Theorem to evaluate real integrations, Z- Transform.</p>	7
02	<p><b>Module: Statistical Techniques</b></p> <p>2.1 Karl Pearson's Coefficient of correlation (<math>r</math>).            2.2 Spearman's Rank correlation coefficient (<math>R</math>) (repeated and non-repeated ranks)            2.3 Lines of regression.            2.4 Fitting of first and second degree curves.  <b>Self-learning Topics:</b> Covariance, fitting of exponential curve.</p>	6
03	<p><b>Module: Probability Distributions</b></p> <p>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 &amp; normal distribution.  <b>Self-learning Topics:</b> Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.</p>	7
04	<p><b>Module: Linear Algebra: Vector Spaces:-</b></p> <p>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.  <b>Self-Learning Topics:-</b> Linear combinations, linear Dependence and Independence, QR decomposition.</p>	6
05	<p><b>Module: Linear Algebra: Quadratic Forms</b></p> <p>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.  <b>Self-learning Topics:</b> Orthogonal Transformations, Applications of Quadraticforms and SVD in Engineering.</p>	7
06	<p><b>Module: Calculus of Variations:</b></p> <p>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.  <b>Self-Learning Topics:-</b> Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action, Several dependent variables.</p>	6

### In Semester Assessment(ISA):

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be 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.

as

### 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 (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC402	Integrated Circuit Design	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC402	Integrated Circuit Design	20	30	50	100

Course Code	Course Name	Credits
<b>BMC402</b>	<b>Integrated Circuit Design</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To provide concepts of operational amplifier (Op-Amp) with their applications and design methodology.</li> <li>To cover analysis of circuits using various ICs.</li> <li>To design and develop various circuits for biomedical applications and to develop analytical thinking of students.</li> </ul>	
<b>Course Outcomes</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Demonstrate basics of operational amplifiers.</li> <li>Analyse different types of Op-Amp based circuits.</li> <li>Analyse and design operational amplifier to perform mathematical operations.</li> <li>Design operational amplifier based oscillators.</li> <li>Learn various waveform generation ICs and their applications to use effectively in projects.</li> <li>Apply the knowledge of various special function ICs and special purpose diodes for designing practical applications.</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Operational Amplifier (Op-Amp):</b> 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.	<b>Linear Application of Op-Amp:</b> 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.	<b>Non-Linear Applications of operational Amplifier:</b> 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 Converter; Introduction to additional Op-Amp ICs and their features: CA3140E, TL081CN, TL061CP, TL071CP, MC33171N, TL0xx, MCP601 and OPA602.	10
4.	<b>Oscillators using Operational Amplifier:</b> 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.	<b>Special Function ICs - 1:</b> 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.	<b>Special Function ICs – 2:</b> 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

#### 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/>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC403	Principles of Control Systems	3	-	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC403	Principles of Control Systems	20	30	50	100

Course Code	Course Name	Credits
<b>BMC403</b>	<b>Principles of Control Systems</b>	3
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To make the learner aware of fundamental concepts of Control systems and mathematical modelling of the system.</li> <li>• To make learner study the state variable representation of control system</li> <li>• To make learner know the concept of time response and frequency response of the system.</li> <li>• The learner should be able to do stability analysis of the system and aware of PID controllers</li> </ul>	
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>• To describe basic concepts of control system such as open loop, closed loop, feedback and feed forward systems</li> <li>• To develop the mathematical model of different type of systems</li> <li>• To analyze systems using state space techniques</li> <li>• To analyse stability in time domain using root locus and BIBO stability</li> <li>• To examine correlation between stability analysis of systems in time and frequency domain</li> <li>• To analyse effect of PID controller in control design</li> </ul>	

Module No.	Contents	Hours
1	<b>Introduction to Control System Analysis:</b> Open loop and closed loop systems; Feedback and feed forward control structure; Examples of control systems.	03
2	<b>Mathematical Modelling of Systems:</b> 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	<b>State Variable Models :</b> 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	<b>Stability Analysis in Time Domain:</b> 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	<b>Stability Analysis in Frequency Domain:</b> 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	<b>Concept of feedback controllers:</b> Concept of proportional, PI and PID Controllers	03

#### **Books Recommended:**

#### **Text Books:**

1. Modern Control Engineering : D.Roy Choudhury, PHI
2. Modern 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](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](https://swayam.gov.in/nd1_noc20_ee62/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC404	Medical Imaging – I	3	-	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC404	Medical Imaging – I	20	30	50	100

Course Code	Course Name	Credits
<b>BMC404</b>	<b>Medical Imaging-I</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the learners with the various Imaging modalities in medicine, their operating principles and quality control aspects.</li> <li>To keep the learners abreast with the technological developments in the field of Medical Imaging.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Discuss different parts of a X-Ray Equipment and outline process of X-Ray Interaction with matter.</li> <li>Explain concepts of Radiography techniques such as Computed Radiography(CR), Digital Radiography (DR) and Mammography with focus on its clinical applications.</li> <li>Explain working principle of Fluoroscopic Imaging and Digital Subtraction Angiography and outline its clinical applications.</li> <li>Describe system configuration of Computed Tomography, Apply CT Image Reconstruction Algorithms and enlist its clinical applications.</li> <li>Highlight the key advancements in CT Technology and demonstrate its application in area of Clinical angiography and Cardiac CT</li> </ul>	

Module	Contents	Hours
1.	<b>X- Ray Imaging:</b> 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.	<b>Radiography Techniques &amp; Applications:</b> Principle and working of Computed Radiography, Digital Radiography and Mammography with its clinical applications.	06
3.	<b>Fluoroscopic Imaging:</b> X-Ray Image Intensifier, Principle and Working of C-Arm, Digital Subtraction Angiography and its clinical applications.	04
4.	<b>Principle of Computed Tomography:</b> 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.	<b>CT Reconstruction Techniques:</b> Radon Transform, Iterative, Filtered Back Projection and Fourier reconstruction.	04
6.	<b>Advancements in CT:</b> Multi-Detector Computed Tomography (MDCT), FlatPanel Detectors, Contrast agents in CT, CT-Angiography & Cardiac CT.	05

#### 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 (MarcelDekkar Pub).

#### 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 (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC405	Biomaterials and Artificial Organs	3	-	--	3	--	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC405	Biomaterials and Artificial Organs	20	30	50	100

Course Code	Course Name	Credits
<b>BMC405</b>	<b>Biomaterials and Artificial Organs</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the fundamentals of biomaterials used for manufacturing implants that has wide application in healthcare industry.</li> <li>To understand design considerations and materials used for manufacturing of various artificial organs.</li> </ul>	
<b>Course Outcomes</b>	Learners will be able to <ul style="list-style-type: none"> <li>Classify various biomaterials and select biomaterials for specific application</li> <li>Explain biological, mechanical and physio-chemical tests conducted on biomaterials before implantation in the human body.</li> <li>Explain properties and applications of metals and ceramic biomaterials.</li> <li>Explain properties and applications of polymeric, degradable and composite biomaterials.</li> <li>Explain design aspects and materials used in the fabrication of artificial organs.</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Biomaterials and Surface Properties of Biomaterials:</b> 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 spectroscopy for chemical analysis (ESCA), secondary ion mass spectrometry (SIMS), infrared spectroscopy, contact angle method.	06
2.	<b>Testing of Biomaterials:</b> Mechanical Testing; Physiochemical Testing; Biological Testing: In-vitro testing, In-vivo testing of Biomaterials.	06
3.	<b>Metallic Biomaterials:</b> Properties, applications and biocompatibility of stainless steel, titanium, titanium based alloys and cobalt – chromium alloys in fabrication of bio-devices and implants.	04
4.	<b>Ceramic Biomaterials:</b> Classification of ceramic biomaterials; Properties, applications and biocompatibility of alumina, zirconia, bioglass, calcium phosphate and tricalcium phosphate in fabrication of bio-devices and implants.	04
5.	<b>Polymeric Biomaterials:</b> 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 bio-devices and implants. <b>Composite Biomaterials:</b> Classification, properties, and applications of composite biomaterials in fabrication of bio-devices and implants.	09
6.	<b>Artificial Organs:</b> 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

### Books Recommended:

#### Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundamentals 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, 2<sup>nd</sup> 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/>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML401	Integrated Circuit DesignLab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML401	Integrated Circuit DesignLab	25		25	50

Course Code	Course Name	Credits
<b>BML401</b>	<b>Integrated Circuit Design Lab</b>	<b>01</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To study op-amp parameters and understand the data sheet.</li> <li>To provide designing methodologies for basic circuits like amplifiers, filters, oscillators etc. using operational amplifiers.</li> <li>To implement the circuits on bread boards for verifying the outputs and obtain frequency response.</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Read the data sheet of different ICs, compare the parameters to select appropriate IC.</li> <li>To design and implement various building blocks of different biomedical instruments.</li> </ul>	

**Syllabus: Same as that of BMC403 Linear Integrated Circuits**

#### List of Laboratory Experiments: (Any seven)

- To study op-amp parameters.
- To design and verify outputs of inverting amplifier, noninverting amplifier and voltage follower.
- Design and verify the outputs of adder and subtractor.
- To design and verify output of instrumentation amplifier.
- To study frequency response of an integrator
- To study frequency response of differentiator.
- To study peak detector circuit.
- To study half wave rectifier and full wave rectifier.
- To study RC-phase shift oscillator.
- To study Wein bridge oscillator.
- To study comparators and zero crossing detector.
- To design and study band pass filter using op-amp
- To design and study notch filter.
- To study monostable multivibrator using IC 555
- To study astable multivibrator using IC555
- To verify outputs of IC 8038

Any other experiment based on syllabus which will help learner to understand topic/concept

### **In Semester Assessment (ISA):**

ISA shall consist of minimum 10 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork

### **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 (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML402	Principles of Control Systems Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML402	Principles of Control Systems Lab	25			25

Course Code	Course Name	Credits
<b>BML402</b>	<b>Principles of Control Systems Lab</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make the learner aware of fundamental concepts of Control systems and mathematical modelling of the system.</li> <li>To make learner study the state variable representation of control system</li> <li>To make learner know the concept of time response and frequency response of the system.</li> <li>The learner should be able to do stability analysis of the system and aware of PID controllers</li> </ul>	
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>To describe basic concepts of control system such as open loop, closed loop, feedback and feed forward systems</li> <li>To develop the mathematical model of different type of systems</li> <li>To analyse systems using state space techniques</li> <li>To analyse stability in time domain using root locus and BIBO stability</li> <li>To examine correlation between stability analysis of systems in time and frequency domain</li> <li>To analyse effect of PID controller in control design</li> </ul>	

#### 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

### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory 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. Modern 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](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](https://swayam.gov.in/nd1_noc20_ee62/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML403	Medical Imaging – I Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML403	Medical Imaging – I Lab	25		25	50

Course Code	Course Name	Credits
<b>BML403</b>	<b>Medical Imaging-I</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the learners with the various Imaging modalities in medicine, their operating principles and quality control aspects.</li> <li>To keep the learners abreast with the technological developments in the field of Medical Imaging.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Discuss different parts of a X-Ray Equipment and outline process of X-Ray Interaction with matter.</li> <li>Explain concepts of Radiography techniques such as Computed Radiography (CR), Digital Radiography (DR) and Mammography with focus on its clinical applications.</li> <li>Explain working principle of Fluoroscopic Imaging and Digital Subtraction Angiography and outline its clinical applications.</li> <li>Describe system configuration of Computed Tomography, Apply CT Image Reconstruction Algorithms and enlist its clinical applications.</li> <li>Highlight the key advancements in CT Technology and demonstrate its application in area of Clinical angiography and Cardiac CT</li> </ul>	

**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)

### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory 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 Dekker Pub).

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML404	Computing Lab (SBL)	--	4	--	--	2	--	2

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML404	Computing Lab (SBL)	25		25	50

Course Code	Course Name	Credits
<b>BML404</b>	<b>Computing Lab (Skill Based Lab)</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand basic concepts of Python programming language.</li> <li>To understand decision controls and functions</li> <li>To understand the utilization of various libraries in Python</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Describe Numbers, Strings, Lists, Tuples, Dictionaries, Array and Mathfunctions in Python</li> <li>Express different Decision Making statements and Functions</li> <li>Illustrate different file handling operations</li> <li>Interpret object oriented programming in Python</li> <li>Develop proficiency in handling Python libraries</li> </ul>	

Module	Contents	Hours
<b>1</b>	<b>Introduction to Python</b> Installation and resources; Introduction of the Python object types: Numbers, Strings, Lists, Tuples, Dictionaries, Arrays; Numeric types; Assignments; Expressions; Print statements and formats.	<b>08</b>
<b>2</b>	<b>Decision Control Statements and Functions:</b> 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.	<b>10</b>
<b>3</b>	<b>Files Handling:</b> Types of Files in Python, Opening a File, Closing a File. WritingText 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	<b>10</b>
<b>4</b>	<b>Object Oriented Programming:</b> 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.	<b>08</b>
<b>5</b>	<b>Numpy, Matplotlib:</b> 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.	<b>10</b>

<b>6</b>	<b>Pandas, Seaborn:</b> Introduction to Pandas: Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation. Introduction to Seaborn.	<b>06</b>
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### 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

### In Semester Assessment (ISA):

ISA shall consist of minimum 12 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory 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)

### PTEL/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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut	Total
BMM401	Mini Project – 1 B	--	4	--	--	2	--	2

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM401	Mini Project – 1 B	25		25	50

Course Code	Course Name	Credits
<b>BMM401</b>	<b>Mini Project – 1 B</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>• To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>• To familiarize the process of solving the problem in a group.</li> <li>• To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>• To inculcate the process of self-learning and research.</li> </ul>	
<b>Course Outcome</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>• Identify problems based on societal /research needs.</li> <li>• Apply Knowledge and skill to solve societal problems in a group.</li> <li>• Develop interpersonal skills to work as member of a group or leader.</li> <li>• Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>• Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>• Use standard norms of engineering practices</li> <li>• Excel in written and oral communication.</li> <li>• Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>• Demonstrate project management principles during project work.</li> </ul>	

## 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:

### In Semester Assessment (ISA):

- 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 ISA 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



# **Vidyalankar Institute of Technology**

*(Autonomous Institute Affiliated to the University of Mumbai)*

## **Scheme and Detailed Syllabus**

**of**

**Third Year**

**in**

**Bachelor of Engineering**

**in**

**Biomedical Engineering**

(Curriculum of REV- 2019 'C' Scheme of UoM)

With effect from Academic Year 2022-23

**Program Structure for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**Semester V**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC501	Biomedical Instrumentation – I	3	--	3	--	3
BMC502	Digital Signal Processing	3	--	3		3
BMC503	Microcontrollers and Embedded Systems	4	--	4	--	4
BMC504	Medical Imaging – II	3	--	3	--	3
BMDO501X	Department Optional Course – 1	3	--	3	--	3
BML501	Biomedical Instrumentation – I Laboratory	--	2	--	1	1
BML502	Digital Signal Processing Laboratory	--	2	--	1	1
BML503	Microcontrollers and Embedded Systems Laboratory	--	2	--	1	1
BML504	Professional Communication and Ethics – II	--	2*+2	--	2	2
BMM501	Mini Project – 2 A	--	4\$	--	2	2
<b>Total</b>		<b>16</b>	<b>14</b>	<b>16</b>	<b>07</b>	<b>23</b>

**Evaluation Scheme for Third Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester V**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC501	Biomedical Instrumentation – I	20	30	50	100
BMC502	Digital Signal Processing	20	30	50	100
BMC503	Microcontrollers and Embedded Systems	20	30	50	100
BMC504	Medical Imaging – II	20	30	50	100
BMDO501X	Department Optional Course – 1	20	30	50	100
BML501	Biomedical Instrumentation – I Laboratory	25		25	50

BML502	Digital Signal Processing Laboratory	25		25	50
BML503	Microcontrollers and Embedded Systems Laboratory	25		25	50
BML504	Professional Communication and Ethics – II	25		25	50
BMM501	Mini Project – 2 A	25			25
<b>Total</b>		<b>225</b>	<b>150</b>	<b>350</b>	<b>725</b>

Total Contact Hours/week :29

Total Credit : 23

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

\* Theory class to be conducted for full class 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.

**Sem. V: Department Optional Course –**

- BMDO5011: Principles of Communication Engineering
- BMDO5012: Very Large Scale Integration
- BMDO5013: Tissue Engineering

**Program Structure for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**  
**Semester VI**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC601	Biomedical Instrumentation – II	3	--	3	--	3
BMC602	Biomedical Digital Image Processing	3	--	3		3
BMC603	Data Analysis in Healthcare	3	--	3	--	3
BMC604	Biomechanics, Prosthetics and Orthotics	3	1	3	--	4
BMDO601X	Department Optional Course – 2	3	--	3	--	3
BML601	Biomedical Instrumentation – II Laboratory	--	2	--	1	1
BML602	Biomedical Digital Image Processing Laboratory	--	2	--	1	1
BML603	Data Analysis in Healthcare Laboratory	--	2	--	1	1
BML604	Patient- care Automation Laboratory	--	4	--	2	2
BMM601	Mini Project – 2 B	--	4 <sup>\$</sup>	--	2	2
<b>Total</b>		<b>15</b>	<b>15</b>	<b>15</b>	<b>07</b>	<b>23</b>

**Evaluation Scheme for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**  
**Semester VI**

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC601	Biomedical Instrumentation – II	20	30	50	100
BMC602	Biomedical Digital Image Processing	20	30	50	100
BMC603	Data Analysis in Healthcare	20	30	50	100
BMC604	Biomechanics, Prosthetics and Orthotics	20+25(T)	30	50	125

BMDO601X	Department Optional Course – 2	20	30	50	100
BML601	Biomedical Instrumentation – II Laboratory	25		25	50
BML602	Biomedical Digital Image Processing Laboratory	25		25	50
BML603	Data Analysis in Healthcare Laboratory	25		25	50
BML604	Patient-care Automation Laboratory	25			25
BMM601	Mini Project – 2 B	25		25	50
<b>Total</b>		<b>250</b>	<b>150</b>	<b>350</b>	<b>750</b>

Total Contact Hours/week :30

Total Credit : 23

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

**Sem. VI: Department Optional Course – 2**

- BMDO6011: Nuclear Medicine
- BMDO6012: Advanced Embedded Systems
- BMDO6013: Telemedicine

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC501	Biomedical Instrumentation – I	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC501	Biomedical Instrumentation – I	20	30	50	100

Course Code	Course Name	Credits
<b>BMC501</b>	<b>Biomedical Instrumentation - I</b>	<b>03</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basic principles and working of diagnostic and therapeutic equipment.</li> <li>To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Explain the principles of various analytical instruments used in hospital and laboratories.</li> <li>Demonstrate knowledge about various blood cell counting systems and blood gas analyzers.</li> <li>Demonstrate knowledge about various automated drug delivery systems.</li> <li>Explain the basics of pulmonary function analyzer, ventilators, and demonstrate the use of ventilation therapy and anesthesia machine.</li> <li>Explain the basic principle and working of hemodialysis machine.</li> </ul>	

Module	Contents	Hours
<b>1.</b>	<p><b>Basic principle, working and technical specifications of Analytical Instruments</b></p> <ol style="list-style-type: none"> <li>Colorimeter</li> <li>Spectrophotometer</li> <li>Auto Analyzer</li> <li>Principles of Electrophoresis apparatus</li> <li>Principles of Chromatography</li> <li>ELISA concepts (direct and indirect), reader &amp; washer.</li> </ol>	<b>10</b>

2.	<b>Basic principle, working and technical specifications of Blood cell counter</b> (Coulter and Pico-scale) <b>Blood Gas Analyzer</b>	<b>04</b>
3.	<b>Automated drug delivery systems</b> Infusion pumps, components of drug infusion systems, syringe and peristaltic pumps.	<b>04</b>
4.	<b>Basic principle and working of Pulmonary Function Analyzer</b> Respiration measurement technique: lung volume and capacities, spirometry, nitrogen washout, helium dilution,	<b>06</b>
5.	<b>Basic principle and working of Ventilators</b> Artificial ventilation, ventilator terms and its types, modes of ventilators, classification of ventilators, pressure volume flow and time diagrams. microprocessor controlled ventilator <b>Basic principle and working of Anesthesia Machine</b> Need for anesthesia, anesthesia machine: gas supply, flow and delivery system vapor delivery and humidification and patient breathing capnography.	<b>10</b>
6.	<b>Basic principle, working and technical specifications of Hemodialysis machine</b> Basic principle of dialysis, different types of dialyzer membranes, portable dialysers and various monitoring circuits.	<b>05</b>

#### 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 : Leslie 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 (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC502	Digital Signal Processing	3	--	3		3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC502	Digital Signal Processing	20	30	50	100

Course Code	Course Name	Credits
<b>BMC502</b>	<b>Digital Signal Processing</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in signal and image processing through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> <li>To train and motivate for higher education and research in order to make contribution to state of the art health care for all.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in digital processing of bio-signals.</li> <li>Understand circular and linear convolution and their implementation using Z-transform and DFT.</li> <li>Understand and implement efficient computational techniques like FFT.</li> <li>Design FIR and IIR filters by different methods.</li> </ul>	

Module	Contents	Hours
1.	Basic elements of Digital Signal Processing, concepts of frequency in analog and digital signals, sampling theorem, discrete time signals and systems their properties, Z-transform and properties, Linear & circular convolution, Correlation, DTFT.	08
2.	Introduction to DFT, Properties of DFT, DIT and DIF, FFT algorithms, use of FFT in linear filtering, discrete cosine transforms.	08
3.	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.	06

<b>4.</b>	Structure of FIR filters, linear phase filters, filter design using window technique, frequency sampling techniques, finite word length effects in digital filters, realisation of FIR & IIR filters, direct, cascade and parallel forms.	<b>06</b>
<b>5.</b>	Introduction to digital signal processors, architecture, features, addressing formats, functional mode, introduction to commercial processors, applications.	<b>03</b>
<b>6.</b>	Preliminaries, biomedical signals (ECG, EMG, EEG) origin & dynamics, statistical preliminaries, time domain filtering (synchronized averaging, moving average), time domain filtering (moving average filter to integration-derivative based operator), Frequency domain filtering (notch Filter), optimal filtering: Wiener filter, adaptive filtering, selecting appropriate filter	<b>08</b>

#### 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, 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 - Pearson Publication
3. Biomedical Digital Signal Processing -- Willis J. Tompkins -- EEE, PHI, 2004
4. R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC503	Microcontrollers and Embedded Systems	4	--	4	--	4

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC503	Microcontrollers and Embedded Systems	20	30	50	100

Course Code	Course Name	Credits
<b>BMC503</b>	<b>Microcontrollers and Embedded Systems</b>	<b>04</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To provide the knowledge about the 8051 microcontroller architecture and programming so that the learners can apply the this knowledge to design microcontroller-based application</li> <li>To make learners aware of the basics of embedded systems and real time operating system</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Explain the fundamentals of embedded systems</li> <li>Apply the knowledge of 8051 Microcontroller architecture</li> <li>Apply the knowledge of 8051 programming in assembly and C language</li> <li>Design and analyse 8051 interfacing with external memory, input/output devices and PC</li> <li>Apply the concept of serial communication protocols</li> <li>Explain the concept of Real Time Operating Systems (RTOS)</li> </ul>	

Module	Contents	Hours
1.	<b>Embedded systems:</b> Definition, characteristics, constraints; processor embedded into a system; embedded hardware units and devices in a system; embedded software in a system; examples of embedded systems; design process in embedded system; classification of embedded systems.	<b>04</b>

2.	<b>8051 Microcontroller Architecture:</b> Introduction: Von Neumann and Harvard architecture, CISC and RISC architecture, comparison of microprocessor and microcontrollers; 8051 hardware block diagram, pin diagram, CPU timing and machine cycles; 8051 programmer model, SFRs and PSW; 8051 Memory organization, parallel I/O ports, integrated peripherals such as timers/counters, serial port, interrupt structure; 8051 Power saving modes.	12
3.	<b>8051 Microcontroller Programming:</b> 8051 assembly language programming process, programming tools; 8051 assembly language: addressing modes, instruction set; assembly language programming and embedded C programming.	12
4.	<b>8051 Microcontroller Interfacing:</b> 8051 interfacing (and related programs) with - external memory, keypad, LED, LCD, ADC and sensors, DAC, relays and d.c. motors, stepper motor; Interfacing 8051 with pc using RS232.	12
5.	<b>Serial Communication Protocols:</b> Operation of serial port, programming for asynchronous serial communication; Serial communication using the 'I2C', SPI; Introduction to USB & CAN bus.	06
6.	<b>Real Time Operating Systems (RTOS):</b> Introduction to RTOS concept, RTOS functions, System timer, process/tasks and task states; RTOS scheduler and algorithms; interrupt latency, interrupt response time as performance metrics; example of small RTOS based systems.	06

### Books Recommended:

#### Text books:

1. The 8051 microcontrollers by Kenneth J Ayala, Cengage Learning.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C by M A Mazidi, J G Mazidi and R D McKinlay, Pearson Education.
3. Using MCS-51 Microcontroller by Han-Way Huang, Oxford University Press.
4. 8051 microcontroller: Hardware, Software & Applications by V Udayashankara, M Mallikarjunaswamy, McGraw Hill Education.
5. Embedded Systems-Architecture, Programming and Design, Rajkamal, Tata McGraw Hill.

#### Reference Books:

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Embedded Microcomputer Systems - Real Time Interfacing by Valvano, Cengage Learning.
3. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid, Toney Givargis - John Wiley Publication.
4. An Embedded Software Primer by David E. Simon - Pearson Education.

### NPTEL/Swayam Course:

Course: Microprocessors and Microcontrollers (Video) by Prof. Santanu Chattopadhyaya from IIT Kharagpur.

<https://nptel.ac.in/courses/108/105/108105102/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC504	Medical Imaging – II	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC504	Medical Imaging – II	20	30	50	100

Course Code	Course Name	Credits
<b>BMC504</b>	<b>Medical Imaging - II</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities.</li> <li>To keep the learners abreast with the technological developments in the field of Medical Imaging.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand use of Ultrasound in medicine, distinguish various ultrasonic display system, understand the construction and operation of the ultrasonic transducer.</li> <li>Understand the Doppler effect and clinical applications of Doppler Techniques.</li> <li>Describe working principle and physics involved in Magnetic Resonance Imaging (MRI)</li> <li>Understand the hardware of MRI Machine, Spin echo Imaging, Pulse sequence, image reconstruction, resolution and SNR, Biological effects, and clinical applications.</li> <li>To understand the basic principle of Magnetic Resonance Spectroscopy.</li> <li>To understand principle and working of Endoscopy and Thermography systems and its clinical applications.</li> </ul>	

Module	Contents	Hours
1	<b>Ultrasound Imaging</b> Introduction, production and characteristics of ultrasound, interaction of ultrasound with matter. ultrasound transducers and instrumentation. real time ultrasound.	08
2	<b>Doppler Ultrasound</b> Doppler effect, continuous wave and pulsed wave doppler system, 2D-echo, clinical applications.	04
3	<b>Physics of MRI</b> Magnetic dipole moments, relaxation parameters, spin echo, magneticfield gradients, slice selection, phase and frequency encoding.	06
4	<b>Magnetic Resonance Imaging</b> Hardware: magnets, gradient coils, RF coils, spin echo imaging, inversionrecovery pulse sequence, image reconstruction, resolution and factors affecting signal-to-noise. safety considerations and biological effects of MRI, clinical applications.	09
5	<b>Magnetic Resonance Spectroscopy (MRS)</b> Basic principle of MRS, metabolites studied, STEAM and PRESS pulse sequences, chemical shift imaging, single-voxel and multivoxel MRS, water suppression techniques.	06
6	<b>Endoscopy and Thermography</b> Working principle, equipment, and its applications.	06

### Books Recommended:

#### Textbooks:

1. *Christensen's Physics of Diagnostic Radiology*, Thomas S. Curry, James E. Dowdey, Robert C.Murry. Wolters Kluwer, Fourth Edition.
2. *Medical Imaging Physics*, William R. Hendee, E. Russell Ritenour. Wiley, Fourth Edition.
3. *Physics of Diagnostic Imaging*, David Dowsett, Patrick A Kenny, R Eugene Johnston. CRC Press,Second Edition.

#### Reference Books:

1. *Biomedical Technology and Devices*, James Moore, George Zouridakis. CRC Press, SecondEdition.
2. *The Biomedical Engineering Handbook*, Joseph D. Bronzino, CRC Press, Second Edition.
3. *MRI: The Basics*, Ray H. Hashemi, William G. Bradley, Christopher J. Lisanti. Lippincott Williams& Wilkins, Second Edition.

#### NPTEL/Swayam Links:

Medical Image Analysis, Dr. Debdoot Sheet, Indian Institute of Technology, KharagpurCourse  
Link: <https://nptel.ac.in/courses/108/105/108105091/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMDO501X	Department Optional Course – 1	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5011	<b>Principles of Communication Engineering</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO501X</b>	<b>Principles of Communication Engineering</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To provide concepts, principles and techniques used in analog and digital communications.</li> <li>To cover a range of digital modulation techniques which are frequently used in modern communication systems.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Demonstrate concept of electronic communication system with effect of noise and modelling of noise</li> <li>Have in depth knowledge of amplitude modulation and understand the AM transmitters and Receiver system with characteristics.</li> <li>Exhibit basic operation of FM transmitter and receiver with types, analysis, advantages and disadvantages</li> <li>Understand and compare the different types of Analog pulse modulation techniques</li> <li>Understand the different types of Digital pulse modulation techniques with merits and demerits</li> <li>Understand and compare different types of digital transmission techniques and multiplexing techniques</li> </ul>	

Module	Contents	Hours
1.	<p><b>Introduction to communication system and noise:</b></p> <ul style="list-style-type: none"> <li>Elements of communication system, types of communication system</li> <li>Noise definition, types, signal to noise ratio, noise factor, noise figure, noise temperature</li> </ul>	<b>04</b>
2.	<p><b>Amplitude Modulation Transmission and Receivers:</b></p> <ul style="list-style-type: none"> <li>Definition, mathematical analysis of AM wave, different types of AM, spectrum, bandwidth,</li> <li>AM transmitter: high and low level AM transmitter, DSB and SSB transmitter (any one method)</li> <li>AM receiver: characteristics: sensitivity, selectivity, fidelity, double spotting, Image frequency and its rejection, dynamic range, super-heterodyne receiver, double conversion receiver</li> </ul>	<b>07</b>

3.	<b>Frequency Modulation Transmission and Receivers:</b> <ul style="list-style-type: none"> <li>• Principles of FM waveform, spectrum, bandwidth</li> <li>• FM generation: direct and indirect FM transmitter</li> <li>• Principles of AFC, effect of noise in FM, noise triangle, pre-emphasis and de-emphasis</li> <li>• FM Receivers: block diagram</li> <li>• Types: simple slope detector, balanced slope detector, Foster Seeley discriminator, ratio detector, quadrature detector</li> <li>• Capture effect in FM receivers, difference between AM and FM system</li> </ul>	10
4.	<b>Analog Pulse Modulation Techniques:</b> <ul style="list-style-type: none"> <li>• Analog modulation techniques: PAM, PWM, PPM – generation, detection, advantages, disadvantages.</li> </ul>	05
5.	<b>Digital Pulse Modulation Techniques:</b> <ul style="list-style-type: none"> <li>• Digital pulse modulation techniques: PCM, DPCM, DM and ADM–generation, detection, advantages and disadvantages.</li> </ul>	05
6.	<b>Digital Transmission Techniques and Multiplexing:</b> <ul style="list-style-type: none"> <li>• Digital transmission types: ASK, FSK, PSK - generation, detection, advantages and disadvantages.</li> <li>• Multiplexing techniques: concept of multiplexing, FDM, TDM, hierarchy, applications, advantages and disadvantages.</li> </ul>	08

#### 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



1. Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO5012	Very Large Scale Integration (Abbreviated asVLSI)	03	--	--	03	--	--	03

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5012	Very Large-Scale Integration	20	30	50	100

Course Code	Course Name	Credits
BMDO5012	Very Large-Scale Integration	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make the learner aware of fundamental concepts of Hardware Description Languages</li> <li>To make learner study working of MOSFET</li> <li>To make learner know the CMOS Circuits.</li> <li>The learner should be able to know the MOSFET fabrication processes</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to ...</b></p> <ul style="list-style-type: none"> <li>To describe hardware description language used to model circuits.</li> <li>To develop some basic digital circuits using HDL</li> <li>To analyze the physics of MOS devices.</li> <li>To compare characteristics of various inverter circuits</li> <li>To compare the fabrication technology used in IC fabrication and how system clocking is designed.</li> <li>To design layouts for various digital gates applying the design rules</li> </ul>	

ModuleNo.	Contents	Hours
1.	<b>Physics of MOSFET</b> MOSFET, threshold voltage, linear and saturated operation, FET capacitance, Scaling of MOS circuits, types of scaling and limitations of scaling-short channel and hot electron effect.	05
2.	<b>MOSFET Inverters:</b> MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active and passive load nMOS inverters, CMOS inverter, voltage transfer characteristics, noise immunity and noise margins.	05

3.	<b>Silicon Semiconductor Technology:</b> Wafer processing, mask generation, oxidation, epitaxial growth, diffusion, ion implantation, photolithography, etching, metallization, basic nMOS and pMOS processes. Latch up in CMOS and CMOS using twin tub process.	07
4.	<b>Introduction to VLSI Clocking and System Design:</b> 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.	06
5.	<b>Design rules and Layout</b> 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.	08
6.	<b>Hardware Description Language</b> Introduction to VHDL hardware description language, core features of VHDL, data types, different modeling styles and architectures of VHDL, Combinational and Sequential Logic design using VHDL	08

### Books Recommended:

#### Text Books:

1. CMOS Digital Integrated Circuits, Kang, Tata McGraw Hill Publications, Third Edition
2. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, 1990
3. Basic VLSI Design, D.A. Pucknell and Eshraghian, Prentice Hall of India, 2005
4. Digital Design Principles and Practices, John F Wakerly, Prentice Hall of India, Third edition
5. Circuit Design with VHDL, Volnei A. Pedroni, Prentice Hall of India, 2009
6. Introduction to VLSI Circuits and Systems- John P. Uyemura, Wiley

#### Reference Books:

1. VHDL Programming by Examples, Douglas Perry, McGraw Hill Publications, 2008
2. Principles of CMOS VLSI Design : A Systems Perspective, Neil H.E. Weste, Kamran Eshraghian Addison Wesley Publications, Second edition, 1993

1. Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO5013	Tissue Engineering (Abbreviated as TE)	03	--	--	03	--	--	03

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5013	Tissue Engineering	20	30	50	100

Course Code	Course Name	Credits
BMDO5013	Tissue Engineering	03
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basics and terminologies of tissue engineering.</li> <li>Learn importance of stem cells in tissue engineering</li> <li>To understand the basic concepts of cell culture</li> <li>To understand applications of tissue engineering in medical field</li> </ul>	
<b>Course Outcome</b>	<b>Learner will be able...</b> <ul style="list-style-type: none"> <li>To get acquainted with cellular responses</li> <li>To understand role of extracellular matrix in tissue engineering</li> <li>To understand cell characteristics.</li> <li>To understand tissue culture and cryopreservation techniques.</li> <li>To understand the selection of various biomaterials for tissue engineering</li> <li>To understand tissue engineering applications</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Tissue Engineering:</b> Fundamentals of stem cell tissue engineering, mechanical forces on cells, cell adhesion, cell migration, inflammatory and immune responses to tissue, cell death- biological description of apoptosis, tissue types.	07
2.	<b>Extracellular Matrix:</b> Structure, function, components, synthesis of the collagens, The ECM - cell binding and long-term contact.	05
3.	<b>Measurement of cell characteristics:</b> Cell morphology, cell number and viability, cell-fate processes, cell motility, cell function.	05
4.	<b>Cell and tissue culture:</b> Types of tissue culture, media, culture environment and maintenance of cells in -vitro, cryopreservation. problems with the culture, organ culture.	06
5.	<b>Biomaterials in Tissue Engineering:</b> Biodegradable polymers and polymer scaffold processing. biomimetic materials, nanocomposite scaffolds, gene therapy, bioreactors for tissue engineering.	06

<b>6.</b>	<b>Tissue Engineering – regeneration:</b> Skin, bone marrow, nervous system, muscle, ligaments and cartilage, cardiac muscles - myocardial tissue engineering, strategies to deliver stem cells to the damaged site.	<b>10</b>
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### Books Recommended:

#### Text books:

1. Bernhard O. Palsson, Sangeeta N. Bhatia, "Tissue Engineering", Pearson Prentice Hall Publishers, 2009.
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", CRC Press LLC, 2006.
3. John P. Fisher, Antonios G. Mikos and Joseph D. Bronzino, "Tissue Engineering", CRC Press LLC, 2007.
4. W. W. Minuth, R. Strehl and K. Schumacher, "Tissue Engineering- Essentials for Daily Laboratory Work", Wiley-VCH Verlag GmbH & Co. KGaA, 2005.
5. Daniel Eberli, "Tissue Engineering for Tissue and Organ Regeneration", InTech, 2011.

#### Reference books:

1. Raphael Gorodetsky, Richard Schäfer, "Stem Cell Based Tissue Repair", RSC Publishing, 2011.
2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2004, Academic Press, 2004.
3. R. Lanza, J. Gearhart et. al. (Eds), "Essential of Stem Cell Biology", Academic press, 2009
4. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine", Artech House, INC Publications, 2008.
5. Naggy N. Habib, M.Y. Levicar, L. G. Jiao and N. Fisk, "Stem Cell Repair and Regeneration", volume-2, Imperial College Press, 2007.
6. Cato T. Laurencin, Lakshmi S. Nair, "Nanotechnology and Tissue engineering - The Scaffold", CRC Press, 2015.
7. Meyer, U., Meyer, Th., Handschel, J., Wiesmann, H.P., "Fundamentals of Tissue Engineering and Regenerative Medicine" Springer, 2009.
8. Lanza RP, Langer R, Vacanti J. "Principles of Tissue Engineering", Third edition. Academic Press. 2007.

### NPTEL/Swayam Links:

Course 1: Tissue Engineering

<https://nptel.ac.in/courses/102/106/102106081/>

Course 2: Tissue Engineering

<https://nptel.ac.in/courses/102/106/102106036/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML501	Biomedical Instrumentation – I Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML501	Biomedical Instrumentation – I Laboratory	25		25	50

**Syllabus: Same as that of (BMC501) Biomedical Instrumentation- -I (BMI-I)**

**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 5V, 1A regulated power supply
4. Design and implementation of temperature controller circuit for hemodialysis machine
5. Design and implementation of pulse width modulator
6. Demonstration of ventilators
7. Demonstration of anesthesia machine
8. Calculations of lung volumes and capacities
9. 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:

### In Semester Assessment (ISA)

ISA shall consist of minimum 7 experiments.

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

## 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: Leslie 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 (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML502	Digital Signal Processing Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML502	Digital Signal Processing Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML502</b>	<b>Digital Signal Processing Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in signal and image processing through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> <li>To train and motivate for higher education and research in order to make contribution to state of the art health care for all.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in digital processing of bio-signals.</li> <li>Understand circular and linear convolution and their implementation using Z-transform and DFT.</li> <li>Understand and implement efficient computational techniques like FFT.</li> <li>Design FIR and IIR filters by different methods.</li> </ul>	

**Syllabus: Same as that of BMC502 Digital Signal Processing (Abbreviated as DSP)**

**List of Experiments (using Matlab / C / Labview / python / other platform)**

1. Basics of programming
2. Simulations of standard signals
3. Concept of aliasing
4. Linear convolution circular convolution
5. Discrete Fourier Transform (DFT )
6. Design and simulation of FIR filter
7. IIR filters using Butterworth approximation
8. IIR filter using Chebyshev approximation
9. Pan-Tompkin algorithm for R-wave detection

## Assessment:

### In Semester Assessment (ISA)

ISA shall consist of minimum 7 experiments.

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

### 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, 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 - Pearson Publication
3. Biomedical Digital Signal Processing -- Willis J. Tompkins -- EEE, PHI, 2004
4. R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002



Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML503	Microcontrollers and Embedded Systems Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML503	Microcontrollers and Embedded Systems Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML503</b>	<b>Microcontrollers and Embedded Systems Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Give the students skills in both simulation and practical implementation of the basic building blocks of 8051 microcontroller-based applications including timers/counters, PWM generation, I/O techniques and requirements, DC motors, stepper motors, keyboard, display device and serial communications</li> <li>Give students skills in 8051 microcontroller programming.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Design different programs using C compilers for 8051 controller</li> <li>Design and develop 8051 embedded C programs for timer based applications</li> <li>Design and develop 8051 embedded C programs for control of DC motors and stepper motors</li> <li>Design and develop 8051 embedded C programs for interfacing keyboard and display device</li> <li>Design and develop 8051 embedded C programs for interfacing with the PC</li> </ul>	

**Syllabus: Same as that of BMC503 Microcontrollers and Embedded Systems (Abbreviated as MES).**

**List of Laboratory Experiments:**

**Any eight experiments to be performed in hardware mode and/or software simulation mode.**

1. To demonstrate basic I/O toggling and interrupts of 8051.
2. To generate precise delay and trigger pulses using 8051 timer.

3. To generate waveform and perform PWM using 8051 timer.
4. To interface 8051 with relay and DC motor (using H bridge) – demonstration through basic I/O toggling.
5. To control the speed of DC motor through PWM based MOSFET switching.
6. To interface 8051 with the stepper motor.
7. To interface 8051 with the seven-segment display.
8. To interface 8051 with the keyboard.
9. To interface 8051 with PC using UART and RS232 standard.

**Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.**

### **In Semester Assessment (ISA)**

ISA shall consist of minimum 8 experiments.

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

### **Books Recommended:**

#### ***Textbooks:***

1. The 8051 microcontrollers by Kenneth J Ayala, Cengage Learning.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C by M A Mazidi, J G Mazidi and R D McKinlay, Pearson Education.
3. Using MCS-51 Microcontroller by Han-Way Huang, Oxford University Press.
4. 8051 microcontroller: Hardware, Software & Applications by V Udayashankara, M Mallikarjunaswamy, McGraw Hill Education.
5. Embedded Systems-Architecture, Programming and Design, Rajkamal, Tata McGraw Hill.

### **Reference Books:**

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Embedded Microcomputer Systems - Real Time Interfacing by Valvano, Cengage Learning.
3. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid, Toney Givargis - John Wiley Publication.
4. An Embedded Software Primer by David E. Simon - Pearson Education.

### **NPTEL/Swayam Course:**

Course: Microprocessors and Microcontrollers (Video) by Prof. Santanu Chattopadhyaya from IIT Kharagpur.  
<https://nptel.ac.in/courses/108/105/108105102/>

**Practical exam consists of performance of any one practical from the conducted experiments within this semester**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML504	Professional Communication and Ethics – II	--	2*+2	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML504	Professional Communication and Ethics – II	25		25	50

Course Code	Course Name	Credits
<b>BML504</b>	<b>Professional Communication &amp; Ethics - II</b>	<b>02</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To discern and develop an effective style of writing important technical/business documents.</li> <li>• To investigate possible resources and plan a successful job campaign.</li> <li>• To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.</li> <li>• To develop creative and impactful presentation skills.</li> <li>• To analyse personal traits, interests, values, aptitudes and skills.</li> <li>• To understand the importance of integrity and develop a personal code of ethics.</li> </ul>	

<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• plan and prepare effective business/ technical documents which will inturn provide solid foundation for their future managerial roles.</li> <li>• strategize their personal and professional skills to build a professional image and meet the demands of the industry.</li> <li>• emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.</li> <li>• deliver persuasive and professional presentations.</li> <li>• develop creative thinking and interpersonal skills required for effective professional communication.</li> <li>• apply codes of ethical conduct, personal integrity and norms of organizational behaviour.</li> </ul>
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Module	Contents	Hours
1	<p><b>ADVANCED TECHNICAL WRITING :PROJECT/PROBLEMBASED LEARNING (PBL)</b></p> <p><b>1.1 Purpose and Classification of Reports:</b> <b>Classification on the basis of:</b></p> <ul style="list-style-type: none"> <li>• Subject Matter (Technology, Accounting, Finance, Marketing, etc.)</li> <li>• Time Interval (Periodic, One-time, Special)</li> <li>• Function (Informational, Analytical, etc.)</li> <li>• Physical Factors (Memorandum, Letter, Short &amp; Long)</li> </ul> <p><b>1.2. Parts of a Long Formal Report:</b></p> <ul style="list-style-type: none"> <li>• Prefatory Parts (Front Matter)</li> <li>• Report Proper (Main Body)</li> <li>• Appended Parts (Back Matter)</li> </ul> <p><b>1.3. Language and Style of Reports</b></p> <ul style="list-style-type: none"> <li>• Tense, Person &amp; Voice of Reports</li> <li>• Numbering Style of Chapters, Sections, Figures, Tables and Equations</li> <li>• Referencing Styles in APA &amp; MLA Format</li> <li>• Proofreading through Plagiarism Checkers</li> </ul> <p><b>1.4. Definition, Purpose &amp; Types of Proposals</b></p> <ul style="list-style-type: none"> <li>• Solicited (in conformance with RFP) &amp; Unsolicited Proposals</li> <li>• Types (Short and Long proposals)</li> </ul> <p><b>1.5. Parts of a Proposal</b></p> <ul style="list-style-type: none"> <li>• Elements</li> <li>• Scope and Limitations</li> <li>• Conclusion</li> </ul> <p><b>1.6. Technical Paper Writing</b></p> <ul style="list-style-type: none"> <li>• Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and</li> </ul>	06

	<p>References)</p> <ul style="list-style-type: none"> <li>• Language and Formatting</li> <li>• Referencing in IEEE Format</li> </ul>	
2	<p><b>EMPLOYMENT SKILLS</b></p> <p><b>2.1. Cover Letter &amp; Resume</b></p> <ul style="list-style-type: none"> <li>• Parts and Content of a Cover Letter</li> <li>• Difference between Bio-data, Resume &amp; CV</li> <li>• Essential Parts of a Resume</li> <li>• Types of Resume (Chronological, Functional &amp; Combination)</li> </ul> <p><b>2.2 Statement of Purpose</b></p> <ul style="list-style-type: none"> <li>• Importance of SOP</li> <li>• Tips for Writing an Effective SOP</li> </ul> <p><b>2.3 Verbal Aptitude Test</b></p> <ul style="list-style-type: none"> <li>• Modelled on CAT, GRE, GMAT exams</li> </ul> <p><b>2.4. Group Discussions</b></p> <ul style="list-style-type: none"> <li>• Purpose of a GD</li> <li>• Parameters of Evaluating a GD</li> <li>• Types of GDs (Normal, Case-based &amp; Role Plays)</li> <li>• GD Etiquettes</li> </ul> <p><b>2.5. Personal Interviews</b></p> <ul style="list-style-type: none"> <li>• Planning and Preparation</li> <li>• Types of Questions</li> <li>• Types of Interviews (Structured, Stress, Behavioural, Problem Solving &amp; Case-based)</li> <li>• Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual</li> </ul>	06
3	<p><b>BUSINESS MEETINGS</b></p> <p><b>a. Conducting Business Meetings</b></p> <ul style="list-style-type: none"> <li>• Types of Meetings</li> <li>• Roles and Responsibilities of Chairperson, Secretary and Members</li> <li>• Meeting Etiquette</li> </ul> <p><b>3.2. Documentation</b></p> <ul style="list-style-type: none"> <li>• Notice</li> <li>• Agenda</li> <li>• Minutes</li> </ul>	02
4	<p><b>TECHNICAL/ BUSINESS PRESENTATIONS</b></p> <p><b>a. Effective Presentation Strategies</b></p> <ul style="list-style-type: none"> <li>• Defining Purpose</li> <li>• Analysing Audience, Location and Event</li> <li>• Gathering, Selecting &amp; Arranging Material</li> <li>• Structuring a Presentation</li> <li>• Making Effective Slides</li> <li>• Types of Presentations Aids</li> <li>• Closing a Presentation</li> <li>• Platform skills</li> </ul> <p><b>b. Group Presentations</b></p>	02

	<ul style="list-style-type: none"> <li>• Sharing Responsibility in a Team</li> <li>• Building the contents and visuals together</li> <li>• Transition Phases</li> </ul>	
<b>5</b>	<p><b>INTERPERSONAL SKILLS</b></p> <p><b>a. Interpersonal Skills</b></p> <ul style="list-style-type: none"> <li>• Emotional Intelligence</li> <li>• Leadership &amp; Motivation</li> <li>• Conflict Management &amp; Negotiation</li> <li>• Time Management</li> <li>• Assertiveness</li> <li>• Decision Making</li> </ul> <p><b>5.2 Start-up Skills</b></p> <ul style="list-style-type: none"> <li>• Financial Literacy</li> <li>• Risk Assessment</li> <li>• Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)</li> </ul>	<b>08</b>
<b>6</b>	<p><b>CORPORATE ETHICS</b></p> <p><b>6.1 Intellectual Property Rights</b></p> <ul style="list-style-type: none"> <li>• Copyrights</li> <li>• Trademarks</li> <li>• Patents</li> <li>• Industrial Designs</li> <li>• Geographical Indications</li> <li>• Integrated Circuits</li> <li>• Trade Secrets (Undisclosed Information)</li> </ul> <p><b>6.2 Case Studies</b></p> <ul style="list-style-type: none"> <li>• Cases related to Business/ Corporate Ethics</li> </ul>	<b>02</b>

#### List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

#### Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end-semester presentation based on the book report.

#### Assessment:

## **In Semester Assessment(ISA)**

ISA shall consist of minimum 8 experiments.

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

## **INTERNAL ORAL - 25 MARKS**

**Oral Examination will be based on a GD & the Project/Book Report presentation.**

Group Discussion : 10 marks

Project presentation

Individual Presentation : 10 Marks

Group Dynamics : 5 Marks

### **Books Recommended:**

#### **Textbooks and Reference books:**

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). *Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) *Technical Communication, Principles and Practice*. Oxford University Press
7. Archana Ram (2018) *Place Mentor, Tests of Aptitude For Placement Readiness*. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). *Communication Skills a workbook*, New Delhi: Oxford University Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMM501	Mini Project – 2 A	--	4\$	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM501	Mini Project – 2 A	25			25

<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>To familiarize the process of solving the problem in a group.</li> <li>To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>To inculcate the process of self-learning and research.</li> </ul>
<b>Course Outcome</b>	<p><b>Learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Identify problems based on societal /research needs.</li> <li>Apply Knowledge and skill to solve societal problems in a group.</li> <li>Develop interpersonal skills to work as member of a group or leader.</li> <li>Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>Use standard norms of engineering practices</li> <li>Excel in written and oral communication.</li> <li>Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>Demonstrate project management principles during project work.</li> </ul>

### 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 solutions and select the best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into a 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 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. 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 a case by case basis.

### **Guidelines for Assessment of Mini Project:**

#### **In Semester Assessment (ISA)**

- 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 – VI**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC601	Biomedical Instrumentation – II	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC601	Biomedical Instrumentation – II	20	30	50	100

Course Code	Course Name	Credits
<b>BMC601</b>	<b>Biomedical Instrumentation-II</b>	<b>03</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basic principles and working of different Biomedical monitoring systems.</li> <li>To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>To develop core competency and skill in the field of Biomedical Engineering to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Provide a better understanding about various bioelectrical signal recorders and patient safety along with greater emphasis on health care equipment and the advanced technologies such as Telemetry and Telemedicine.</li> <li>Demonstrate the principles of electronics used in designing various biomedical monitoring equipment.</li> <li>Understand the basic principles and working of audiometry equipments and hearing aids</li> <li>Provide a better understanding about foetal and neonatal monitoring systems.</li> <li>Acquire the ability to explain the various blood flow and cardiac output measurement devices.</li> </ul>	

Module	Contents	Hours
1.	<b>Basic principle, working and technical specifications of</b> ECG, EMG and EEG machines, LEAD configurations, 10-20 electrode system measuring techniques for EOG, ERG and phonocardiography, <b>Patient Safety:</b> Electric shock hazards, leakage currents, safety codes for electro-medical equipment.	08
2.	<b>Arrhythmia and Patient monitoring:</b> Cardiac arrhythmias, Stress test measurement, ambulatory monitoring instruments such as holter monitor. <b>Basics of Telemetry, Multi-channel Telemetry.</b>	08
3.	<b>Basic principle and working of Patient Monitoring Systems</b> Measurement of heart rate, pulse rate, blood pressure, temperature and respiration rate, apnea detector. Heart rate variability measurement. <b>Point of care devices and their design considerations for homecare devices:</b> glucometer.	08
4.	<b>Basic principle and working of Audiometers and hearing aid</b> Basic audiometer, pure tone and speech audiometer, evoked response audiometry, introduction to hearing aids and cochlear implants.	05
5.	<b>Basic principle and working of Foetal and Neonatal Monitoring System</b> Cardiotocograph, methods of monitoring of foetal heart rate, monitoring of labour activity, incubator and infant warmer, non-stress test monitoring.	05
6.	<b>Basic principle and working of Blood flowmeters</b> Electromagnetic, ultrasonic, NMR and laser doppler flowmetry, <b>Measurement of Cardiac Output</b> Indicator dilution, dye dilution and thermal dilution techniques.	05

### 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: Leslie 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC602	Biomedical Digital Image Processing	3	--	3		3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC602	Biomedical Digital Image Processing	20	30	50	100

Course Code	Course Name	Credits
<b>BMC602</b>	<b>Biomedical Digital Image Processing</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>To be able to think about applying different Image processing techniques on a given image.</li> <li>To know the fundamental concepts of a digital image processing techniques</li> <li>To be able to analyze problem and design algorithms to solve the problems.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description.</li> <li>Analyze images in the spatial domain.</li> <li>Analyze images in the frequency domain through the Fourier transform.</li> <li>Apply the concepts of morphology, representation and description on images.</li> <li>Design and implement with MATLAB/C/Python algorithms for digital image processing.</li> </ul>	

Module	Contents	Time
1.	<b>Basics of Image Processing:</b> 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.	06
2.	<b>Image Enhancement:</b> 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, basics of colour image processing.	09
3.	<b>Image Segmentation:</b> Basic relationships between pixels, neighbours, adjacency, connectivity, regions, boundaries, distance measures; detection of discontinuities, point, line and edges, edge linking, Hough transform, thresholding based segmentation, region-based segmentation.	06

4.	<b>Image Transforms &amp; Image Compression:</b> DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, basis functions and basis images, introduction to wavelet transform, fundamentals of image compression models, lossless compression, RLE, Huffman, LZW and arithmetic coding techniques, lossy compression - IGS coding, transformcoding, JPEG, JPEG 2000.	08
5.	<b>Morphology, Representation and Description:</b> Dilation, erosion, open, close, hit-or-miss, boundary extraction, region filling, thinning and thickening; chain codes, polygonal approximations, signatures; fourier descriptors, moments.	04
6.	<b>Feature Recognition and Classification:</b> Object recognition and classification, connected components labelling, features, statistical classification, structural/syntactic classification, applications in medical image analysis	06

#### 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 - Printice Hall India.

#### Reference Books:

1. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge University Press, 2009..
2. Digital Image Processing, William Pratt - John Wiley.

#### NPTEL/Swayam Course:

Course:

Digital Image Processing - NPTEL Lecture Videos by Prof. P.K. Biswas from IIT Kharagpur.

<http://www.nptelvideos.com/course.php?id=541>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC603	Data Analysis in Healthcare	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC603	Data Analysis inHealthcare	20	30	50	100

Course Code	Course Name	Credits
<b>BMC603</b>	<b>Data Analysis in Healthcare</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To cover basic concepts and theory related to statistics.</li> <li>To focus on various statistical abilities such as analysis of variance, hypothesis testing, estimation, etc.</li> </ul>	
<b>Course Outcomes</b>	<p>The learner will be able to :</p> <ul style="list-style-type: none"> <li>Understand the basic techniques and nomenclatures used for statistical analysis of data</li> <li>Describe the importance of normalizing data</li> <li>Apply statistical methods to sample data</li> <li>Analyze data using parametric statistical methods</li> <li>Develop a strong foundation for designing algorithms for computation.</li> <li>Design statistical models separately for parametric and non-parametric analysis.</li> </ul>	

Module	Contents	Hours
1	<b>Descriptive statistics, probability and sampling distributions:</b> Frequency distribution, measures of central tendency, measures of dispersion, basic probability and Bayes theorem, Binomial, Poisson and normal distributions, sampling distributions of sample mean, difference between two sample means, sample proportions and difference between two sample proportions	09
2	<b>Estimation:</b> Confidence intervals for population mean, difference between two population means, population proportion, difference between two population proportions, t-distribution, variance of normally distributed population, ratio of variances of two normally distributed populations, determination of sample size for estimating mean and proportions	06
3	<b>Hypothesis testing:</b> Type – I and II errors, hypothesis testing for population mean, difference between two population means, population proportions, difference between two population proportions, population variance and ratio of two population variances, power of test	06
4	<b>Analysis of variance:</b> 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	06
5	<b>Chi square distribution and analysis of frequency:</b> Chi-square distribution and properties, test of goodness of fit, independence and homogeneity of data	06
6	<b>Non-parametric analysis:</b> Distribution free tests such as one sample sign test, rank sum test, Mann-Whitney U-test, Kruskal-Wallis test, cluster analysis, data mining methods	06

#### 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
4. Research Methodology Methods and Techniques by C. R Kothari and Gaurav Garg, Fourth Edition, New Age international publishers.

#### 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

#### NPTEL/Swayam Course:

Course:

Introduction to Data Analytics by Prof. Nandan Sundarsanam – IIT-M and Prof. B. Ravindran – IIT-M

<https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-mg06/>

Data analytics with Python by Prof. A. Ramesh - IIT Roorkee

<https://nptel.ac.in/courses/106/107/106107220/>



Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC604	Biomechanics, Prosthetics and Orthotics	3	1	3	--	4

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC604	Biomechanics, Prosthetics and Orthotics	20+25(T)	30	50	125

Course Code	Course Name	Credits
<b>BMC604</b>	<b>Biomechanics, Prosthetics and Orthotics</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>Recall the general characteristics, mechanical properties of bone and tissues.</li> <li>Analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biological tissues.</li> <li>Understand principles used in designing orthoses and prostheses</li> <li>Study different materials used for orthoses and prosthesis.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Explain the basic principles of Biomechanics</li> <li>Explain the mechanical behavior of Biological Tissues</li> <li>Explain about various joints and its movements</li> <li>Explain the techniques adopted for analyzing joint movements.</li> <li>Explain the general principles followed while designing Orthoses and prosthesis.</li> <li>Explain the applications of various Prosthetic and Orthotic devices.</li> </ul>	

Module	Contents	Time
	<b>BIOMECHANICS</b>	
1.	<b>Force system:</b> Classification of force system, equilibrium of force system, principle of biomechanics	<b>02</b>
2.	<b>Tissue Biomechanics:</b> Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. stress relaxation and creep. Bone structure & composition, mechanical properties of bone, biomechanical evaluation of bone using three points and four points. Biomechanics of connective tissues (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.	<b>10</b>
3.	<b>Movement Biomechanics:</b> Study of joints and movements, anatomical levers, gait analysis, gait cycle and gait parameters	<b>04</b>
4.	<b>Joint analysis:</b> Instrumentation for gait analysis: measurement devices-footswitches, instrumented walkway, motion analysis - Selspot, goniometers, joint monitoring sensors and joint monitoring parameters	<b>05</b>

	<b>PROSTHETICS AND ORTHOTICS</b>	
<b>5.</b>	<b>Principles in designing orthoses and prostheses:</b> Principles of three point pressure, total contact, partial weight bearing.	<b>05</b>
<b>6.</b>	<b>Classification in prosthetics and orthotics:</b> Lower extremity orthoses and prostheses, upper extremity orthoses and prostheses, spinal orthoses.	<b>13</b>

**Tutorials:** Eight tutorials are to be conducted from the below list.

1. Components of biomechanics
2. Role of biomechanics in exercises
3. Biomechanics and body movements
4. Gait cycle
5. Evaluation of gait parameters
6. Orthotic devices associated with sports injuries
7. Advancements in materials used for orthotic devices
8. Prosthetic rehabilitation
9. Advancements in materials used for prosthetic devices

**Text books:**

1. Basic Biomechanics- Susan J. Hall, MC Graw Hill.
2. Basics of Biomechanics" by Dr. Ajay Bahl and others
3. Basic Biomechanics of the Musculoskeletal System, M. Nordin, V. Frankel
4. Human Limbs and their substitutes – Atlas, C. V. Mosby
5. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
6. American Atlas of Orthopedics: Orthotics, C. V. Mosby
7. Biomechanics - Prof Ghista (Private Publication UAE)
8. Biomechanics – By White and Puyator (Private Publication UAE)

**Reference Books:**

1. Introductory Biomechanics: from cells to tissues by Ethier and Simmons
2. Biomechanics: Mechanical properties of living tissues by Y. C. Fung

**NPTEL/Swayam Course:**

1. Assistive Devices, Prosthesis and Orthosis, NPTEL Lecture Video by Dr Sujatha Srinivasan, IIT Madras.  
<http://www.digimat.in/nptel/courses/video/112106248/L47.html>
2. Mechanics of Human Movement, Swayam, Lecture Video by Dr Sujatha Srinivasan, IIT Madras.  
[https://onlinecourses.nptel.ac.in/noc21\\_me52/preview](https://onlinecourses.nptel.ac.in/noc21_me52/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6011	<b>Nuclear Medicine</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6011</b>	<b>Nuclear Medicine</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment.</li> <li>To keep the students abreast with the technological developments in the field of nuclear medicine.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learners will be able to</b></p> <ul style="list-style-type: none"> <li>Explain the essential physics of nuclear medicine such as concepts of radioactivity, its measurement, interaction with matter and radionuclide production.</li> <li>Apply the principles of physics to understand working of various detectors and counting systems.</li> <li>Study principle of operation of different scanning system and their quality control function.</li> <li>Explain various Emission Tomography Techniques along with their Clinical Applications.</li> <li>Explain various aspects of radiation safety.</li> <li>Explain concept of radionuclide therapy and the function of radiotherapy equipment.</li> </ul>	

Module	Content	Hours
1.	<p><b>Basics of Nuclear Physics:</b> Radioactivity, radioactive decay law, radioactive decay processes, decay scheme of Mo-99. Units of radioactivity measurement, interaction of radiation with matter</p> <p><b>Production of Radionuclide:</b> Methods of radionuclide production: nuclear reactor, medical cyclotron &amp; radionuclide generators</p>	<b>09</b>
	<p>Spectra of commonly used radio nuclides e.g Tc-99m, Cs-137.</p> <p><b>Radiopharmaceuticals:</b> ideal radiopharmaceutical, methods of radio labelling</p>	

2.	<p><b>Detectors in Nuclear Medicine &amp; Counting and Measuring System:</b> Gas filled detectors, scintillation detectors and solid-state detectors, scintillation counting system, gamma ray spectrometry, radionuclide dose calibrator, properties of detectors.</p> <p><b>In Vitro Techniques (Brief Description):</b> Introduction, single and double isotope method, radioimmunoassay, RIA counting system, liquid scintillation counting system, RIA applications.</p>	07
3.	<p><b>In Vivo Techniques:</b> General principle, uptake monitoring system, rectilinear scanner, gammacamera fundamentals, position circuitry and working, computer interface, performance parameters, quality control functions</p>	06
4.	<p><b>Emission Tomography Techniques and Clinical Applications:</b> Introduction, principles and applications of SPECT, principles and applications of PET, system performance parameters and quality control functions.</p> <p><b>Introduction to Hybrid Modalities:</b> PET/CT, SPECT/CT</p> <p><b>Clinical Applications</b> Clinical applications of PET, SPECT and hybrid modalities in cardiology, neurology and oncology.</p>	07
5.	<p><b>Radiation Safety:</b> Natural &amp; artificial radiation exposure, external &amp; internal radiation hazard, methods of minimizing external exposure, methods of preventing internal exposure, evaluation of external &amp; internal hazard, biological effects of radiation, radioactive waste management.</p>	06
6.	<p><b>Radionuclide Therapy:</b> Choice of a radionuclide in therapeutic nuclear medicine, radiotherapy equipment: cobalt unit, proton beam therapy</p>	04

### Books Recommended:

#### Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea & Febiger.
2. B.R. Bairy, 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.
5. Simon R. Cherry, James A. Sorenson and Michael E. Phelps, *Physics in Nuclear Medicine*, Saunders, an imprint of Elsevier Inc.
6. Janet F. Eary and Winfried Brenner, *Nuclear Medicine Therapy*, informa healthcare

#### Reference 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.

### NPTEL/Swayam Links:

Course 1: Nuclear Science and Engineering, Dr. Santanu Gosh, Indian institute of Technology, Delhi

<https://nptel.ac.in/courses/115/102/115102017/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6012	<b>Advanced Embedded Systems</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6012</b>	<b>Advanced Embedded Systems</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To impart the hardware and software concepts of Embedded System.</li> <li>To introduce the students with Real Time Operating System.</li> <li>To implement the embedded design, ARM Cortex M3 Microcontroller is covered in detail.</li> </ul>	
<b>Course Outcomes</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Explain the fundamentals of embedded systems</li> <li>Understand the characteristics and hardware of embedded system.</li> <li>Understand the software used for an embedded system.</li> <li>Understand interprocess communication.</li> <li>Understand the usage of the development and debugging tools.</li> <li>Explain the concept of Real Time Operating Systems (RTOS) using practical cases.</li> </ul>	

Module	Contents	Hours
<b>1.</b>	<b>ARM Cortex M3:</b> Overview of ARM family, comparison of RISC and CISC architectures. Cortex-M3 architecture, pipelining, BUS interfaces Programmers' model: register set, program status register, operation modes and states. Memory system and memory protection unit (MPU). Exceptions, interrupt architecture: Nested vectored interrupt controller, power management, watchdog timer and systick timer.	<b>08</b>

2.	<b>Introduction to Embedded Systems and Embedded Hardware:</b> characteristics and design metrics of embedded system, challenges in embedded system design, embedded processors, co-processors and hardware accelerators. Processor performance enhancement: pipelining and superscalar architecture. Types of memories and buffers, sensors (optical encoders, resistive sensors) and actuators (solenoid valves, relay/switch, opto-couplers). Power supply considerations in embedded systems: linear and switching voltage regulators, low power features, sleep mode, brown-out detection.	06
3.	<b>Embedded Software – RTOS 01:</b> Features of RTOS, advantages of RTOS, hard and soft real time systems, selecting an RTOS, Kernel architectures and features. Task/Processes and threads, task states, multitasking, interrupt latency. Context Switching: Cooperative multi-tasking and pre-emptive multi-tasking. Task Scheduler: FIFO, round robin, rate-monotonic scheduling, earliest- deadline first scheduling, fault-tolerant scheduling	08
4.	<b>Embedded Software – RTOS 02:</b> Inter-process communication: Semaphores and signals, shared memory communication, message based communication. Memory management, file systems, device management (device drivers), I/O and communications management. Event timers, task synchronization, priority inversion, deadlock. Software design methodologies: UML, FSM, DFG. Evaluating and optimizing operating system performance: response-time calculation, interrupt latency, time-loading, memory loading.	08
5.	<b>FreeRTOS:</b> Study of Kernel structure of FreeRTOS, functions for initialization, task creation, inter-task communication and resource management, memory management. System integration, testing and debugging methodology: Embedded product design life-cycle (EDLC), Hardware-software co-design testing & debugging: Boundary-scan/JTAG interface concepts, black-box testing, white-box testing.	05
6.	<b>Case studies:</b> Chocolate vending machine, washing machine, automotive systems, auto-focusing digital camera, air-conditioner.	04

### Books Recommended:

#### Text books:

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill
2. Software Design for Real-Time Systems: Cooling, J E, *published by* Chapman and Hall in 1991 ...ISBN 978-0-442-31174-2
3. Embedded System Design: A unified Hardware/software Introduction by Frankvahid/TonyGivargis, Wiley India Edition
4. Real-Time Systems Design and Analysis: An Engineer's Handbook: Laplante, Phillip A by IEEEpress, Wiley-Interscience, A John Wiley and Sons Inc, Publications
5. Embedded / Real-Time Systems: Concepts, Design and Programming Black Book, New ed(MISL-DT)

#### Reference Books:

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Dreamteach Software team, Programming for Embedded Systems, AVR 8515 manual
3. Bruce Powel Douglas, "Real-Time UML, Second Edition: Developing Efficient Object for Embedded Systems, 2nd edition ,1999, Addison-Wesley
4. An Embedded Software Primer by David E. Simon - Pearson Education, 2003

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6013	Telemedicine	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6013</b>	<b>Telemedicine</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>• Learn the key principles for telemedicine and e-health care.</li> <li>• Understand telemedicine technology.</li> <li>• Know telemedicine standards, mobile telemedicine, and its applications.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Explain the basic principles of healthcare in telemedicine</li> <li>• Discuss the role of telecommunication in Healthcare</li> <li>• Describe various Tele-medicine standards.</li> <li>• Explain the different Components of tele-radiology system</li> <li>• Discuss the various applications of telemedicine</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Telemedicine:</b> Historical perspective and evolution of telemedicine, tele health, tele care, components of telemedicine system, global and indian scenario, ethical and legal aspects of telemedicine, safety and regulatory issues, laws governing telemedicine.	<b>07</b>
2.	<b>Telemedicine Technology:</b> Principles of multimedia – text, audio, video, data, data communications and networks, PSTN, POTS, ANT, ISDN, internet, air/wireless communications: GSM satellite, and micro wave, modulation techniques, integration and operational issues, communication infrastructure for telemedicine, LAN and WAN technology, satellite communications, mobile hand held devices and mobile communication, internet technology, video and audio conferencing, clinical data - local and centralized	<b>06</b>
3.	<b>Telemedicine Standards:</b> Data security and standards: encryption, cryptography, mechanisms of encryption, phases of encryption. Protocols: TCP/IP, ISO-OSI, standards to be followed DICOM, HL7, H.320 series (video phone based ISBN) T.120, H.324 (video phone based PSTN), Video conferencing, real-time telemedicine integrating doctors / hospitals, clinical laboratory data, radiological data, and other clinically significant biomedical data,	<b>06</b>
	administration of centralized medical data, security and confidentiality of medical records and access control, cyber laws related to telemedicine.	

4.	<b>Mobile Based Tele-ECG:</b> Need for mobile based TM, Tele-ECG development, Tele ECG scenario on the globe, extension of mobile based approach for other vitalsignals, cloud based tele-monitoring, personal monitoring, Impact of mobile based Tele-ECG.	<b>06</b>
5.	<b>Mobile Telemedicine:</b> Components of tele-radiology system: Image acquisition system display system, tele pathology, multimedia databases, color images of sufficient resolution, dynamic range, spatial resolution, compression methods, interactive control of color, medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system – doctors, paramedics, facilities available. pharmaceutical information system.	<b>07</b>
6.	<b>Telemedicine Applications:</b> Telemedicine access to health care services – health education and self-care. introduction to robotics surgery, tele-surgery. tele- cardiology, telemedicine in neurosciences, electronic documentation, e-health services security and interoperability., telemedicine access to health care services, health education and self-care, business aspects – project planning, usage of telemedicine.	<b>07</b>

#### Text Books:

1. Norris, A.C. "Essentials of Telemedicine and Telecare", Wiley (ISBN 0-471-53151-0), First edition, 2002.
2. O'Carroll, P.W, Yasnoff W.A., Ward E.Ripp, L.H., Martin, E.L., "Public Health Informatics and Information Systems", Springer (ISBN 0-387-95474-0), 1st Edition, 2003.
3. Ferrer-Roca, O., Sosa-Iudicissa, M, "Handbook of Telemedicine", IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 3rd Edition, 2002.

#### Reference Books:

1. Simpson, W. "Video over IP- A practical guide to technology and applications", Focal Press(Elsevier). ISBN-10: 0-240-80557-7, 2006.
2. Wootton R. Craig, J., Patterson V. "Introduction to Telemedicine", Royal Society of Medicine Press Ltd (ISBN 1853156779), 2nd Edition, 2006.



Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML601	Biomedical Instrumentation – II Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML601	Biomedical Instrumentation – II Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML601</b>	<b>Biomedical Instrumentation – II Laboratory</b>	<b>01</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basic principles and working of patient monitoring system.</li> <li>To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<b>Learner will be able to...</b> <ul style="list-style-type: none"> <li>Design and Implement filters for filtering of noise from signals.</li> <li>Design and Implement Instrumentation amplifier to amplify low amplitude signals.</li> <li>Design and Implement a regulated power supply.</li> <li>Design and Implement Pulse Width Modulator.</li> <li>Understand the working of ECG machine by recording ECG.</li> <li>Provide a better understanding about foetal monitoring systems.</li> <li>Test the hearing ability using an audiometer.</li> </ul>	

### Syllabus: Same as that of (BMC601) Biomedical Instrumentation-II (BMI-II)

#### 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. Demonstration of ECG machine / monitor
6. Demonstration of foetal monitor
7. Demonstration of blood flow measurement
8. Testing of hearing ability using audiometer
9. Industry / hospital visit may 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.

### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.

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

### **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: Leslie 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 (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML602	Biomedical Digital Image Processing Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML602	Biomedical Digital Image ProcessingLaboratory	25		25	50

Course Code	Course Name	Credits
<b>BML602</b>	<b>Biomedical Digital Image Processing Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To be able to think about applying different Image processing techniques on agiven image.</li> <li>To know the fundamental concepts of a digital image processing techniques</li> <li>To be able to analyze problem and design algorithms to solve the problems.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Acquire the fundamental concepts of a digital image processing system such asimage acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description.</li> <li>Analyze images in the spatial domain.</li> <li>Analyze images in the frequency domain through the Fourier transform.</li> <li>Apply the concepts of morphology, representation and description on images.</li> <li>Design and implement with MATLAB/C/Python algorithms for digital imageprocessing.</li> </ul>	

**Syllabus: Same as that of BMC602 Biomedical Digital Image Processing (Abbreviated as BDIP).**

**List of Experiments (using Matlab / C / Labview / python / other platform)**

1. Point processing techniques (At least 4 experiments)
2. Spatial domain filtering
3. Histogram processing (Histogram stretching, equalisation and matching)
4. Frequency domain filtering (Plotting 2D-DFT, low pass and high pass (Ideal, Butterworth andGaussian) filters
5. Segmentation - gradient operators
6. Compression - JPEG
7. Morphology - dilation erosion

**Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.**

**In Semester Assessment (ISA):**

ISA shall consist of minimum 8 experiments.

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

**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 - Printice Hall India.

**Reference Books:**

1. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge University Press, 2009..
2. Digital Image Processing, William Pratt - John Wiley.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML603	Data Analysis in Healthcare Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML603	Data Analysis in Healthcare Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML603</b>	<b>Data Analysis in Healthcare Laboratory</b>	<b>01</b>
<b>Course Objective</b>	To conduct analysis of medical data using Statistical tools.	
<b>Course Outcome</b>	Learner will be able to <ul style="list-style-type: none"> <li>• Plan the experiment for the given study</li> <li>• Form a sample of proper size</li> <li>• Use descriptive statistics to present the data</li> <li>• Apply statistical methods to analyse the data</li> <li>• Make inferences based on statistical theories</li> </ul>	

**Syllabus: Same as that of BML603 Data Analysis in Healthcare (DAH)**

Laboratory experiments may be conducted using Excel/ Python / R Studio /Tableau or any other Statistical tool/ software

#### List of experiments

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
10. Anova
11. Kruskal-Wallis Test
12. Mann Whitney U-test

Any other experiment based on syllabus which will help students to understand topic/concept

#### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

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

### **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

### **NPTEL/Swayam Course:**

#### *Course:*

Data Analysis and Decision Making - I by Prof. Raghunandan Sengupta, IIT Kanpur

<https://nptel.ac.in/courses/110/104/110104094/>

Descriptive Statistics with R Software By Prof. Shalabh, Prof. Prashant Jha IIT Kanpur, NIT Sikkim

[https://onlinecourses.nptel.ac.in/noc21\\_ma37/preview](https://onlinecourses.nptel.ac.in/noc21_ma37/preview)

**Oral examination will be based on suggested practical list and entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML604	Patient- care Automation Laboratory	--	4	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML604	Patient-careAutomationLaboratory	25			25

Course Code	Course Name	Credits
<b>BML604</b>	<b>Patient-care Automation Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the fundamentals of automation and various components of automated instrumentation systems used in patient care such as sensors, data acquisition, data processing and visualization.</li> <li>• To understand the working of these systems and should be able to determine hardware and software requirements for the automated systems.</li> <li>• To understand how to design any application based on these systems.</li> <li>• To understand the requirements of patient safety and design safety instrumented systems</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to ...</b></p> <ul style="list-style-type: none"> <li>• Demonstrate the use of analog circuits in automation of biomedical instruments.</li> <li>• Demonstrate the use of digital circuits in automation of biomedical instruments.</li> <li>• Demonstrate and explain the working of automated patient care devices and instrumentation by proper selection and designing criteria, developing user friendly interfaces/GUI to make stand-alone biomedical instruments.</li> <li>• Explain the need of patient safety and use of safety features and devices in designing of the systems.</li> </ul>	

### List of Experiments (any 7)

1. Conditional decision making and switching of output devices like relays/ motors
2. Usage of indicating components (displays/ LED/ alarms) in biomedical applications
3. Use of peristaltic pump for dispensing the doses
4. Design of heart rate measurement circuits using analog components
5. Design of low-cost body temperature measurement unit
6. Automation of rehabilitation devices using electronic/ mechanical components
7. Design syringe pump driving circuit
8. User friendly user interfaces for biomedical equipment
9. Patient feedback designs using patient switch (audiometer)
10. Patient safety using safety switch (traction machine)
11. Design and approaches for nerve and muscle stimulator using wave form generators

## 12. Design of bio-signal transmission using modulation techniques

Note: The above experiments can be performed using the freeware or available simulation software

No single solution to any design and it depends on the available analog or digital resources.

### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.

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

### **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: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHIPub)

*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 (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMM601	Mini Project – 2 B	--	4\$	--	2	2
<b>Total</b>		<b>15</b>	<b>15</b>	<b>15</b>	<b>07</b>	<b>23</b>

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM601	Mini Project – 2 B	25		25	50

Course Code	Course Name	Credits
<b>BMM601</b>	<b>Mini Project – 2 B</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>• To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>• To familiarize the process of solving the problem in a group.</li> <li>• To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>• To inculcate the process of self-learning and research.</li> </ul>	
<b>Course Outcome</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>• Identify problems based on societal /research needs.</li> <li>• Apply Knowledge and skill to solve societal problems in a group.</li> <li>• Develop interpersonal skills to work as member of a group or leader.</li> <li>• Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>• Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>• Use standard norms of engineering practices</li> <li>• Excel in written and oral communication.</li> <li>• Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>• Demonstrate project management principles during project work.</li> </ul>	

## 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:

### In Semester Assessment (ISA)

- 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



# **Vidyalankar Institute of Technology**

*(Autonomous Institute Affiliated to the University of Mumbai)*

## **Scheme and Detailed Syllabus**

**of**

**Final Year**

**in**

**Bachelor of Engineering**

**in**

**Biomedical Engineering**

(Curriculum of REV- 2019 'C' Scheme of UoM)

With effect from Academic Year 2022-23

**Program Structure for Final Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**  
**Semester VII**

Course Code	Course Name	Teaching Scheme(Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BMC701	Biomedical Instrumentation – III	3	--	3	-	3
BMC702	Machine Learning	3	--	3	-	3
BMDO701X	Department Optional Course – 3	3	--	3	-	3
BMDO702X	Department Optional Course – 4	3	--	3	-	3
BMIO701	Institute Optional Course – 1	3	--	3	-	3
BML701	Biomedical Instrumentation – III Lab	--	2	--	1	1
BML702	Machine Learning Lab	--	2	--	1	1
BMDL701X	Department Optional Course – 3 Lab	--	2	--	1	1
BMP701	Major Project - I	--	6 <sup>#</sup>	--	3	3
<b>Total</b>		<b>15</b>	<b>12</b>	<b>15</b>	<b>6</b>	<b>21</b>

**Evaluation Scheme for Final Year Biomedical Engineering**  
**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**  
**Semester VII**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC701	Biomedical Instrumentation – III	20	30	50	100
BMC702	Machine Learning	20	30	50	100
BMDO701X	Department Optional Course – 3	20	30	50	100
BMDO702X	Department Optional Course – 4	20	30	50	100
BMIO701	Institute Optional Course	20	30	50	100

	- 1				
BML701	Biomedical Instrumentation – III Lab	25		25	50
BML702	Machine Learning Lab	25		25	50
BMDL701X	Department Optional Course – 3 Lab	25		25	50
BMP701	Major Project - I	25		25	50
<b>Total</b>		<b>200</b>	<b>150</b>	<b>350</b>	<b>700</b>

Total Contact Hours/week :27

Total Credit : 21

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

# indicates work load of Learner (Not Faculty), for Major Project

**Sem. VII: Department Optional Course – 3**

BMDO7011: Biological Modeling and Simulation  
BMDO7012: Bioinformatics

BMDO7013: IoT based Systems

**Sem. VII: Department Optional Course**

**– 4**BMDO7021: Rehabilitation Engineering  
BMDO7022: Lasers and Fibre Optics

BMDO7023: Networking and Information Systems in Medicine

**Sem. VII: 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

ILO1019: Development Engineering

**Program Structure for Final Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**Semester VIII**

Course Code	Course Name	Teaching Scheme(Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC801	Hospital Management	3	--	3	--	3
BMDO801X	Department Optional Course – 5	3	--	3	--	3
BMDO802X	Department Optional Course – 6	3	--	3	--	3
BMIO801	Institute Optional Course - 2	3	--	3	--	3
BML801	Hospital Management Lab	--	2	--	1	1
BMDL801X	Department Optional Course – 5 Lab	--	2	--	1	1
BMP801	Major Project - II	--	12 <sup>#</sup>	--	6	6
<b>Total</b>		<b>12</b>	<b>16</b>	<b>12</b>	<b>8</b>	<b>20</b>

**Evaluation Scheme for Final Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester VIII**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC801	Hospital Management	20	30	50	100
BMDO801X	Department Optional Course – 5	20	30	50	100
BMDO802X	Department Optional Course – 6	20	30	50	100
BMIO801	Institute Optional Course - 2	20	30	50	100
BML801	Hospital Management Lab	25		25	50
BMDL801X	Department Optional Course – 5 Lab	25		25	50
BMP801	Major Project - II	100		50	150
<b>Total</b>		<b>230</b>	<b>120</b>	<b>300</b>	<b>650</b>

Total Contact Hours/week : 28



Total Credit :20

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

**Sem. VIII: Department Optional Course –**

**5** BMDO8011: Robotics in Medicine  
BMDO8012: Healthcare Informatics  
BMDO8013: Artificial Intelligence in  
Medicine

**Sem. VIII: Department Optional Course**

**– 6**BMDO8021: Biomedical Microsystems  
BMDO8022: Medical Device Regulations  
BMDO8023: Ergonomics

**Sem. VIII: 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  
Students group and load of faculty per week.

**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

## Semester – VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BMC701	Biomedical Instrumentation – III	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC701	Biomedical Instrumentation – III	20	30	50	100

Course Code	Course Name	Credits
<b>BMC701</b>	<b>Biomedical Instrumentation- -III</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles and working of life Saving Equipment.</li> <li>• To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>• To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Distinguish between the types of pacemakers on the basis of ICHD code and analyze the various circuits.</li> <li>• Apply the knowledge of electronics to analyze defibrillator circuits.</li> <li>• Explain the importance of use of Anesthesia machine and Capnograph during Surgery.</li> <li>• Explain the basic principle, working and applications of surgical equipment with safety aspects.</li> <li>• Explain the importance of measurement of oxygen saturation in human body and application of heart lung machine during surgery.</li> </ul>	

Module	Contents	Hours
1	<b>Cardiac Pacemakers</b> 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.	09
2	<b>Cardiac Defibrillator</b> Need for defibrillator, D C defibrillator, modes of operation and electrodes, performance aspects of dc-defibrillator, implantable defibrillator, cardioverter.	08
3	<b>Physiotherapy equipments</b> Basic principle, working and technical specifications of 1.Shortwave Diathermy 2. Ultrasonic therapy unit 3. Nerve and Muscle Stimulator.	06
4	<b>Surgical equipment</b> Operation theatre Lights and Table. Surgical Diathermy machine, automated electrosurgical systems, electrodes used with surgical diathermy, safety aspects in electronic surgical units.	08
5	<b>Heart Lung machine</b> Heart Lung Machine and types of oxygenators	04
6	<b>Oximeters</b> Basics of oximeter, In-vitro and In-vivo oximetry, ear oximetry, pulse oximetry, skin reflectance oximeters, intravascular oximeters,	04

#### 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: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

##### *Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr –Brown.
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV
3. Various Instrument Manuals.
4. Various internet websites.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BMC702	Machine Learning	3	--	3		3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC702	Machine Learning	20	30	50	100

Course Code	Course Name	Credits
BMC702	Machine Learning	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in artificial intelligence through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> </ul> <p>To train and motivate for higher education and research in order to make contribution to state of the art health care for all</p>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in neural networks, deep learning and machine learning</li> <li>Understand supervised and unsupervised learning, backpropagation and gradient descent algorithms</li> <li>Understand and implement efficient computational techniques using neural networks, deep learning and machine learning</li> </ul> <p>Design and implementation of neural network models with deep learning and machine learning will be strong base for designing artificial intelligent systems</p>	

Module	Contents	Hours
1	<b>Learning methods:</b> Introduction , types of learning, supervised learning, unsupervised learning, statistical learning, reinforcement learning, elements of reinforcement learning, model-based learning, temporal difference learning, linear regression, least squares, linear regression for polynomial regression tasks, logistic regression, model selection and validation,	06
2	<b>Clustering:</b> Introduction, mixture densities, k-means clustering, expectation-maximization algorithm, supervised learning after clustering, spectral clustering, hierarchical clustering, choosing the number of clusters. <b>Decision Trees:</b> Introduction, univariate trees, rule extraction from trees, learning rules from data, multivariate trees, clustering, overfitting and evaluation	06
3	<b>Design and analysis of machine learning experiments:</b> Introduction, factors, response, and strategy of experimentation, response surface design, randomization, replication, and blocking, guidelines for machine learning experiments, cross-validation and resampling methods, measuring classifier performance	06
4	<b>Introduction of artificial neural networks:</b> structure and function of a biological neurons, artificial neuron models, concepts of neural network, single layer and multilayer perceptron, structure of an ANN, feed-forward neural network, gradient descent, back propagation, architectures of neural networks, optimisation of neural network model	07
5	<b>Architecture and training the ANN:</b> Type of learning the neural network, training of a single-layer neural network, delta rule, designing ANN models, radial basis function, overview of learning rules and parameters, activation functions, multilayer feed forward network, backpropagation networks, architecture, radial basis function network	07
6	<b>Fundamentals of deep networks:</b> Deep Learning, architectural principles of deep networks, parameters, layers, loss function , optimization algorithms, hyper parameters, building blocks of deep networks, architectures of deep networks, convolutional neural networks, architecture of convolutional neural networks, input layers, convolutional layers, pooling layers, fully connected layers, recurrent neural networks, architecture of recurrent neural network	07

### Books Recommended:

#### Text books

1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning Private Limited, New Delhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., Gravenstein Highway North, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, Prentice Hall, 2009

#### Reference books

1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education (India) Private Limited New Delhi, 2013

### Useful Links:

1. Course 1: Introduction to Machine Learning  
<https://nptel.ac.in/courses/1061061392>.
2. Course 2: Introduction to Machine Learning  
[https://onlinecourses.nptel.ac.in/noc22\\_cs29/preview](https://onlinecourses.nptel.ac.in/noc22_cs29/preview)

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMDO7011	Biological Modeling and Simulation (Abbreviated asBMS)	3	--	-	3	--	-	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO701X	Biological Modeling and Simulation	20	30	50	100

Course Code	Course Name	Credits
BMDO7011	Biological Modeling and Simulation	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand basic concepts of modeling for designing biological model.</li> <li>To simulate physiological processes for better understanding.</li> <li>To develop competency in terms of logical thinking, programming and application skills</li> <li>To train and motivate students for pursuing higher education and research for developing cutting edge technologies.</li> </ul>	
<b>Course Outcomes</b>	<p><b>A learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Categorise different types of biological models.</li> <li>Develop a model of a neuron using Hodgkin Huxley exp setup.</li> <li>Differentiate a spindle receptor and Golgi tendon bodies.</li> <li>Design a quantitative model for eye movement system.</li> <li>Understand a basic model of a thermoregulatory system.</li> <li>Understand the behaviour of immune system</li> </ul>	

Module	Contents	Time
1	<b>Physiological modeling:</b> Steps in modeling, purpose of modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system.	04
2	<b>Model of neurons:</b> Biophysics tools, Nernst Equation, Donnan Equilibrium, active transport (Pump) GHK equation, action potential, voltage clamp, channel characteristics, Hodgkin- Huxley conductance equations, simulation of action potential, electrical equivalent model of a biological membrane, impulse propagation- core conductor model, cable equations.	11
3	<b>Neuromuscular system:</b> Modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex,reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.	06
4	<b>Eye movement model:</b> Four eye movements, quantitative eye movement models, validity criteria.	06
5	<b>Thermo-regulatory systems:</b> Thermoregulatory mechanisms, electrical model of thermoregulatory system, controller model, validation and application.	06
6	<b>Modeling of other physiological systems. Modeling the immune response:</b> Behavior of the immune system, linearized model of the immune response. Modeling of insulin glucose feedback system and Pulsatile insulin secretion	06

### 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 Ploncy

*Reference Books:*

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7012	Department Optional Course – 3 Bioinformatics (Abbreviated as BI )	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO7012	Bioinformatics	20	30	50	100

Course Code	Course Name	Credits
BMDO7012	Bioinformatics	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>The course introduces the students to the field of Bioinformatics.</li> <li>To make students aware about the methods to characterize and manage the different types of biological data.</li> <li>To introduce students to the basics of sequence alignment and analysis.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to</b></p> <ul style="list-style-type: none"> <li>Get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.</li> <li>Apply knowledge of basic principles of mathematics and statistics.</li> <li>Apply existing software effectively to extract information from large databases and to use this information in computer modelling</li> <li>Apply problem-solving skills to multivariate methods in bioinformatics</li> <li>Search and apply bioinformatics tools to analyse and interpret biological data</li> </ul>	



Module	Contents	Hours
1	<b>Introduction to bioinformatics and biological databases:</b> Basic principles of genetics, cells, DNA and chromosome, genes and the genome, DNA sequencing, proteomics, discovery of gene sequence. Human genome project, biological databases and their classification, genome sequence databases, protein structure databases, composite databases.	08
2	<b>Statistical methods used in bioinformatics:</b> Basic statistical modelling and Bayesian inference, gene expression and microarray analysis, sequence alignment, sequence pattern discovery, combining sequence and expression information.	10
3	<b>Algorithms in bioinformatics:</b> Introduction, dynamic programming and sequence alignment, Needleman–Wunsch algorithm, Greedy algorithms for Genome rearrangement, string algorithm, breakpoint graph, approximation algorithm, FASTA and BLAST algorithms..	08
4	<b>Multivariate Methods in Bioinformatics:</b> Multivariate normal distribution, multivariate hypothesis tests, principle component analysis, orthogonal factor model, linear discriminant analysis, classification methods, Naïve Bayes classification.	06
5	<b>Applications and tools of bioinformatics:</b> Sequence alignment and dotplot, DNA sequence analysis, protein sequence analysis, database similarity search, phylogenetic analysis and tree construction, gene, protein and tissue microarray.	07

#### Recommended Online Courses ( optional):

1. "Bioinformatics and Computational Biology" offered by IIT Kanpur  
<https://piazza.com/iitk.ac.in/secondsemester2018/bse322a/>
2. "Network Analysis in Systems Biology" offered by Icahn School of Medicine at Mount Sinai, in New York City <https://www.coursera.org/learn/network-biology>
3. "Bioinformatics: Introduction and Methods" from Peking University.  
<https://www.coursera.org/learn/bioinformatics-pku>
4. "Biology Meets Programming : Bioinformatics for Beginners", offered by UC San Diego  
<https://www.coursera.org/learn/bioinformatics>

**Books Recommended:***Text books:*

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

*Reference Books:*

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7013	IoT Based Systems (Abbreviated as IoT)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO7013	IoT Based Systems	20	30	50	100

Course Code	Course Name	Credits
BMDO7013	IOT Based Systems	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• Learn the concepts of IOT</li> <li>• Identify different technologies and schemes</li> <li>• Learn different applications in IOT</li> <li>• Learn different protocols used in IOT</li> <li>• Learn how to analyze the data in IOT</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to</b></p> <ul style="list-style-type: none"> <li>• Apply the concepts of IOT</li> <li>• Identify and select different technologies and scheme for IOT applications</li> <li>• Apply IOT to different applications</li> <li>• Analyze and evaluate protocols used in IOT systems</li> <li>• Analyze dataflow in IOT systems</li> </ul>	

Module	Contents	Hours
1	<b>Introduction:</b> History of IoT, Objects in IoT, Identifier in the IoT, Technologies in IoT. What are wireless sensors, Sensor family, Architecture of single node sensor.	04
2	<b>IoT schemes and models:</b> Block diagram of an IoT device (node), characteristics of IoT, functional blocks of IoT, communication models. IoT levels and deployment templates. IoT enabling technologies.	08
3	<b>IoT stack:</b> M2M stack and examples, IoT stack and examples, IoT stack variants, difference between IoT and M2M. IoT Access Technologies: Physical and MAC layers, IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11 and LoRaWAN.	08
4	<b>Network and Communication Aspects:</b> Network Layer Protocols: IPv4 and IPv6, Constrained nodes and Constrained networks Optimizing IP for IoT: From 6LoWPAN to 6Lo, routing over low power and lossy networks. Application Layer Protocols: CoAP and MQTT.	05
5	<b>Components of IoT:</b> IoT platform design methodology. IoT end device computing –boards based on microcontroller and SoC. Sensor technologies, sensor data communication protocols: UART, SPI, I2C.	06
6	<b>IoT Case Studies:</b> Home automation, smart cities, environment monitoring and control, agriculture, retail sector, healthcare and lifestyle, logistics and supply chain, access control and tracking.	08

#### Recommended Online Courses ( optional):

- 1) Introduction To Internet Of Things  
By Prof. Sudip Misra | IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc22\\_cs52/preview](https://onlinecourses.nptel.ac.in/noc22_cs52/preview)
- 2) Introduction To Industry 4.0 And Industrial Internet Of Things  
By Prof. Sudip Misra | IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc22\\_cs52/preview](https://onlinecourses.nptel.ac.in/noc22_cs52/preview)

**Books Recommended:***Text books:*

- 1) Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universitiespress.
- 2) IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
- 3) Data and Computer communications, william stallings, Pearson Education.
- 4) Data communication and networking, Behrouz A. Forouzan, McGraw Hill Education  
Communication Networks, Alberto Leon Garcia, McGraw Hill Education.

*Reference Books:*

- 1) Computer Networks, S. Tanenbaum, Pearson Education.
- 2) Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, AddisonWesley.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7021	Department Level Optional Course –4							
	Rehabilitation Engineering (Abbreviated as RE)	03			03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO7021	Rehabilitation Engineering	20	30	50	100

Course Code	Course Name	Credits
BMDO7021	Rehabilitation Engineering	03
Course Objectives	<ul style="list-style-type: none"> <li>To Introduce the socio-legal aspects of Rehabilitation Engineering</li> <li>To understand the importance of Orthotics, and Prosthesis</li> <li>To introduce learners to basics of Kinetics and Kinematics.</li> <li>To understand the flow properties of blood.</li> <li>To understand various upper and lower limb deformities.</li> <li>To understand the rehabilitation management of various deformities</li> </ul>	
Course Outcomes	<p><b>A learner will be able to</b></p> <ul style="list-style-type: none"> <li>Understand the basic difference between Impairment, Disability and Handicap</li> <li>Understand the reasons for Amputation, need of Orthosis, Prosthesis.</li> <li>Understand the human joint's stability.</li> <li>Understand the flow pattern of blood in normal and abnormal conditions.</li> <li>Understand management of simple to complex deformities</li> <li>Understand the rehabilitation management during paralytic conditions of the limb</li> </ul>	

Module	Contents	Hours
1	<p><b>Introduction and socio-legal aspects of rehabilitation engineering:</b>            Medical rehabilitation, epidemiology of rehabilitation, preventive rehabilitation, impairment disability and handicap.</p>	03
2	<p><b>Orthotics, amputation, and prosthetics, activities of daily living (ADL):</b> Orthotics: General principles of orthotics, biomechanics of orthotics, classification: upper &amp; lower extremity orthotics, spinal orthotics            Amputation &amp; 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 &amp; exo-skeletal prosthetics, classification of upper &amp; lower limb prosthetics            Activities of daily living: ADL grouping, Barthel's index of ADL, functional independence, measures, environmental control system, communication, ADL training.</p>	10
3	<p><b>Mechanical principles of Kinematics and Kinetics:</b>            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.</p>	06
4	<p><b>Flow properties of blood:</b> 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.</p>	06
5	<p><b>Common deformities and role of surgery in rehabilitation engineering.</b> Types of deformities, management of 1<sup>st</sup> and 2<sup>nd</sup> degree deformities, common deformities of lower limb, treatment for partial foot deformities, deformities of the foot, arm Deformities, torticollis</p>	06
6	<p><b>An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:</b>            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 &amp; outcome, management.</p>	08

**Books Recommended:***Text books:*

1. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, ElizabethLaurance 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



Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7022	Lasers & Fiber Optics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO7022	Lasers & Fibre Optics	20	30	50	100

Course Code	Course Name	Credits
BMDO7022	Lasers & Fibre Optics	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To help the students to build up a detailed knowledge of the methods, fabrication, and applications of lasers &amp; fiber optics in medical engineering.</li> <li>To create a platform for students to have deeper understanding on the fundamental principles of lasers and Optical fibers in bio-photonic systems.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Understand types of optical source and its emission properties.</li> <li>Analyze the various types of lasers and their medical applications</li> <li>Familiarize the fundamentals of optical fibers.</li> <li>Understand the interaction of laser with tissue along with its applications</li> <li>Understand and implement the use of lasers and optical fibers for surgery and sensing.</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to optical radiation, emission &amp; resonator:</b> Spontaneous and stimulated emission, Einstein's coefficients, gain coefficient, laser oscillation conditions, population inversion, three and four level systems, rate equations, optical resonators and types, modes and mode stability criteria, losses in optical resonators-quality factor.	06
2.	<b>Types of Lasers:</b> Working principle of Ruby laser, dye laser, argon ion laser, solid state lasers-fundamental and higher harmonic generation. Detailed study of semiconductor lasers, Nd: YAG laser- flash lamp pumped and diode pumped lasers, He-Ne laser, CO <sub>2</sub> laser, excimer laser, nitrogen laser, free electron laser, Ti: Sapphire laser, rare earth doped and photonic crystal fiber based lasers, soliton lasers. Chemical lasers, metal vapors lasers, medical applications of Lasers.	07
3.	<b>Fundamentals of fiber optics:</b> Classification of fibers- step index, graded index fiber, numerical aperture, modes in optical fiber, single mode and multimode fiber, V- parameter, evanescent modes, losses in fiber, dispersion in fiber, special fiber-polarization maintaining fiber, non-linear effects in optical fiber, fiber fabrication techniques, splicing.	07
4.	<b>Photobiology &amp; bioimaging:</b> Interaction of light with cells and tissues, photo-processes in biopolymers, human eye and vision, optical fiber delivery system, Optical coherence tomography, Applications of bio-imaging: bio-imaging probes and fluorophores, Endoscopy.	06
5.	<b>Optical sensors:</b> MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDs for fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators, optical sensor types, advantages and disadvantages of fiber optic sensors, intensity modulated sensors, interferometric sensors, rotation sensors, bio sensors.	07
6.	<b>Laser and fiber activated therapy:</b> Photodynamic therapy, photo-sensitizers for photodynamic therapy, tissue engineering using light, Laser system in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, lasers and fibers in skin treatment.	06

### Books Recommended:

Textbooks:

- • Tu Vo Dinh, Biomedical Photonics: A Handbook- CRC Press, Boca Raton, FL 2003
- • V N Prasad, Introduction to Biophotonics, Wiley-Interscience, 2003
- • Orazio Svelto, Principles of Lasers, 4th Edn, Plenum Press, 1998
- • Dakin J and Culshaw B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998
- • Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York, 2002
- • Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998

Reference Books:

- • Lihong V and Hsin-IWU, Biomedical Optics-Principles, and Imaging - Wiley Interscience 1<sup>st</sup>ed. 2007
- • Mark E.Brezinski, Optical Coherence Tomography-Principles and Applications-(AcademisPress 1<sup>st</sup> ed. 2006)
- • Rodney Cotterill, Biophysics –An Introduction (John Wiley Student edition)

- • Valery .V.Tuchin, A Handbook of Optical Biomedical diagnostics, SPIE press monograph volpm 107
- • Bahaa E. A Saleh & Malvin Carl Teich, Fundamentals of Photonics, John Wiley & Sons, 1991
- • Jeff Hecht, The Laser Guide Book, McGraw Hill, 1986
- • Koechner (W alter), Solid State Laser Engineering, Springer, 1992
- • Marvin J. Weber, Handbook of Lasers, CRC Press, 2001
- • Yariv A, Optical Electronics, 4thEdn, Holt, Rinehart and Winston, 1991

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut	Total
BMDO7023	Department Optional Course – 4 Networking and Information Systems in Medicine (Abbreviated asNISM)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO7023	Networking and Information Systems in Medicine	20	30	50	100

Course Code	Course Name	Credits
BMDO7023	Networking and Information Systems in Medicine	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the fundamental component of computer Networking.</li> <li>To understand the functioning and configuration of various networking devices and components.</li> <li>To understand a concept about network security.</li> <li>Understand various Information system used in Healthcare System</li> <li>To understand the healthcare IT infrastructure Understand various IHE domains</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learners will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental components of computer networks and networking protocols.</li> <li>Understand IP addressing, functioning and configuration of various networking devices and components</li> <li>Understand concepts about network security</li> <li>Understand the PACS components, architecture and PACS tele radiology</li> <li>Understand HIS, RIS, integration of HIS/RIS/PACS, PACS archive storage</li> <li>Understand IHE and IHE domains</li> </ul>	

<b>Module</b>	<b>Contents</b>	<b>Hours</b>
<b>1.</b>	PACS Components; PACS generic workflow; PACS architectures: stand-alone, client-server, and web-based; PACS and teleradiology	<b>06</b>
<b>2.</b>	Introduction to RIS and HIS, HIS/RIS/PACS integration; PACS archive storage: RAID; HIPPA	<b>06</b>
<b>3.</b>	Integrating Healthcare Enterprise: IHE workflow model, IHE domains, IHE patient information reconciliation profile, IHE radiology information integration profile	<b>06</b>
<b>4.</b>	Performance of network/device parameters: bandwidth, throughput, jitter, latency network technology; types of cables and connectors, crossover and straight throughcables, colour coding of cables; OSI Model; TCP/IP, Addressing types (IP, MAC, Port& Specific)	<b>08</b>
<b>5.</b>	IP V4 addressing, subnetting, supernetting; IP V6 addressing; Detailed working of networking equipment: Hub, bridge , switch, router, modem	<b>07</b>
<b>6.</b>	Basic Security Concepts: Security Mechanism and security services, authentication, authorization, confidentiality, integrity, non-repudiation; Symmetric and asymmetric key cryptography, RSA algorithm	<b>06</b>

### **Books Recommended:**

#### *Textbooks:*

1. PACS and Imaging Informatics by H.K. Huang, Second Edition, Wiley and Blackwell.
2. PACS: A Guide to the Digital Revolution by Keith J. Dreyer, Springer.
3. Data Communication and Networking by Behrouz A. Forouzan, McGraw 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, Eric T.T.Wong (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.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO701	Product Life Cycle Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO701	Product Life Cycle Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the students with the need, benefits and components of PLM</li> <li>To acquaint students with Product Data Management &amp; PLM strategies</li> <li>To give insights into new product development program and guidelines for designing and developing a product</li> <li>To familiarize the students with Virtual Product Development</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.</li> <li>Illustrate various approaches and techniques for designing and developing products.</li> <li>Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.</li> <li>Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Introduction to Product Lifecycle Management (PLM):</b>  Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance &amp; Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications <b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM</p>	10

2	<p><b>Product Design:</b>  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</p>	09
3	<p><b>Product Data Management (PDM):</b>  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</p>	05
4	<p><b>Virtual Product Development Tools:</b>  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</p>	05
5	<p><b>Integration of Environmental Aspects in Product Design:</b>  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</p>	05
6	<p><b>Life Cycle Assessment and Life Cycle Cost Analysis:</b>  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</p>	05

## REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springererlag, 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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7012	Reliability Engineering	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7012	Reliability Engineering	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the students with various aspects of probability theory</li> <li>To acquaint the students with reliability and its concepts</li> <li>To introduce the students to methods of estimating the system reliability of simple and complex systems</li> <li>To understand the various aspects of Maintainability, Availability and FMEA procedure</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand and apply the concept of Probability to engineering problems</li> <li>Apply various reliability concepts to calculate different reliability parameters</li> <li>Estimate the system reliability of simple and complex systems</li> <li>Carry out a Failure Mode Effect and Criticality Analysis</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</p> <p><b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</p> <p><b>Measures of Dispersion:</b> Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</p>	08
2	<p><b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</p> <p><b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time ToFailure (MTTF), MTBF, Reliability Functions.</p> <p><b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</p>	08
3	<p><b>System Reliability:</b></p> <p>System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</p>	05



4	<b>Reliability Improvement:</b> 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	<b>Maintainability and Availability:</b> 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	<b>Failure Mode, Effects and Criticality Analysis:</b> Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

#### REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
<b>BMIO7013</b>	<b>Management Information System</b>	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7013	<b>Management Information System</b>	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>The course is blend of Management and Technical field.</li> <li>Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built</li> <li>Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage</li> <li>Identify the basic steps in systems development</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Explain how information systems Transform Business</li> <li>Identify the impact information systems have on an organization</li> <li>Describe IT infrastructure and its components and its current trends</li> <li>Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making</li> <li>Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses</li> </ul>

Module	Detailed Contents	Hours
1	<b>Introduction To Information Systems (IS):</b> Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	<b>04</b>
2	<b>Data and Knowledge Management:</b> Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management <b>Business intelligence (BI):</b> Managers and Decision Making, BI for Data analysis and Presenting Results	<b>07</b>
3	<b>Ethical issues and Privacy:</b> Information Security. Threat to IS, and Security Controls	<b>07</b>

4	<b>Social Computing (SC):</b> Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	<b>07</b>
5	<b>Computer Networks</b> Wired and Wireless technology, Pervasive computing, Cloud computing model.	<b>06</b>
6	<b>Information System within Organization:</b> Transaction Processing Systems, Functional Area Information System, ERP andERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	<b>08</b>

**REFERENCES:**

- 1 Kelly Rainer, Brad Prince, Management Information Systems, Wiley
- 2 K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the DigitalFirm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
- 3 D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization,Prentice Hall, 2008

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7014	Design of Experiments	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7014	Design of Experiments	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the issues and principles of Design of Experiments (DOE)</li> <li>To list the guidelines for designing experiments</li> <li>To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Plan data collection, to turn data into information and to make decisions that lead to appropriate action</li> <li>Apply the methods taught to real life situations</li> <li>Plan, analyse, and interpret the results of experiments</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Introduction</b></p> <p>1.1 Strategy of Experimentation</p> <p>1.2 Typical Applications of Experimental Design</p> <p>1.3 Guidelines for Designing Experiments</p> <p>1.4 Response Surface Methodology</p>	06
2	<p><b>Fitting Regression Models</b></p> <p>2.1 Linear Regression Models</p> <p>2.2 Estimation of the Parameters in Linear Regression Models</p> <p>2.3 Hypothesis Testing in Multiple Regression</p> <p>2.4 Confidence Intervals in Multiple Regression</p> <p>2.5 Prediction of new response observation</p> <p>2.6 Regression model diagnostics</p> <p>2.7 Testing for lack of fit</p>	08

3	<b>Two-Level Factorial Designs</b> 3.1 The $2^2$ Design 3.2 The $2^3$ Design 3.3 The General $2^k$ 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
4	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
5	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
6	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods <b>6.3</b> Robust design examples	04

**REFERENCES:**

- 1 Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> 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, 2<sup>nd</sup> Ed. Wiley
- 4 W J Dimond, Practical Experiment Designs for Engineers and Scientists, 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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7015	Operations Research					
		3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7015	Operations Research	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Formulate a real-world problem as a mathematical programming model.</li> <li>Understand the mathematical tools that are needed to solve optimization problems.</li> <li>Use mathematical software to solve the proposed models.</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.</li> <li>Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.</li> <li>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.</li> <li>Understand the applications of integer programming and a queuing model and compute important performance measures</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Introduction to Operations Research:</b> Introduction, Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> 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, <b>Duality</b>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> 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. <b>Assignment Problem:</b> 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</p> <p><b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	14
2	<p><b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
3	<p><b>Simulation:</b> 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</p>	05
4	<p><b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.</p>	05
5	<p><b>Game Theory.</b> 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.</p>	05
6	<p><b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,</p>	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 andPractice", John Willey and Sons, 2nd Edition, 2009
- 3 Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGrawHill, 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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7016	Cyber Security and Laws	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7016	Cyber Security and Laws	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand and identify different types of cybercrime and cyber law</li> <li>To recognize Indian IT Act 2008 and its latest amendments</li> <li>To learn various types of security standards and compliances</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the concept of cybercrime and its effect on the outside world</li> <li>Interpret and apply IT law in various legal issues</li> <li>Distinguish different aspects of cyber law</li> <li>Apply Information Security Standards compliance during software design and development</li> </ul>

Module	Detailed Contents	Hours
1	<b>Introduction to Cybercrime:</b> 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
2	<b>Cyber offenses &amp; Cybercrime:</b> How criminals plan the attacks, Social Engineering, 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, Device-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
3	<b>Tools and Methods Used in Cyberline:</b> Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6

4	<b>The Concept of Cyberspace :</b> 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
5	<b>Indian IT Act:</b> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
6	<b>Information Security Standard compliances</b> 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, NewDelhi.
4. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth 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-primerprofessionals-33538>

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7017	<b>Disaster Management and Mitigation Measures</b>	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7017	<b>Disaster Management and Mitigation Measures</b>	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand physics and various types of disaster occurring around the world</li> <li>• To identify extent and damaging capacity of a disaster</li> <li>• To study and understand the means of losses and methods to overcome /minimizeit.</li> <li>• To understand role of individual and various organization during and after disaster</li> <li>• To understand application of GIS in the field of disaster management</li> <li>• To understand the emergency government response structures before, during and after disaster</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>• Get to know natural as well as manmade disaster and their extent and possible effects on the economy.</li> <li>• Plan of national importance structures based upon the previous history.</li> <li>• Get acquainted with government policies, acts and various organizational structure associated with an emergency.</li> <li>• Get to know the simple do's and don'ts in such extreme events and act accordingly.</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Introduction</b></p> <p>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.</p>	03
2	<p><b>Natural Disaster and Manmade disasters:</b></p> <p>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</p> <p>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.</p>	09
3	<p><b>Disaster Management, Policy and Administration</b></p> <p>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.</p> <p>3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination 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.</p>	06
4	<p><b>Institutional Framework for Disaster Management in India:</b></p> <p>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.</p> <p>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</p>	06
5	<p><b>Financing Relief Measures:</b></p> <p>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.</p> <p>5.2 International relief aid agencies and their role in extreme events.</p>	09
6	<p><b>Preventive and Mitigation Measures:</b></p> <p>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general</p> <p>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</p> <p>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.</p>	06
	6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	

**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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
BMIO7018	Energy Audit and Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7018	Energy Audit and Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the importance energy security for sustainable development and the fundamentals of energy conservation.</li> <li>To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management</li> <li>To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>To identify and describe present state of energy security and its importance.</li> <li>To identify and describe the basic principles and methodologies adopted in energy audit of a utility.</li> <li>To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.</li> <li>To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities</li> <li>To analyze the data collected during performance evaluation and recommend energy saving measures</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Energy Scenario:</b> 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</p>	04
2	<p><b>Energy Audit Principles:</b> 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 &amp; targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)</p>	08
3	<p><b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. <b>Energy efficiency measures in lighting system, lighting control:</b> 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.</p>	10
4	<p><b>Energy Management and Energy Conservation in Thermal Systems:</b> 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.</p>	10
5	<p><b>Energy Performance Assessment:</b> 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.</p>	04
6	<p><b>Energy conservation in Buildings:</b> Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</p>	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 EnergyResearch 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](http://www.energymanagertraining.com)
- 9 [www.bee-india.nic.in](http://www.bee-india.nic.in)

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
<b>BMIO7019</b>	<b>Development Engineering</b>					
		<b>3</b>	<b>--</b>	<b>3</b>	<b>--</b>	<b>3</b>

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMIO7019	Development Engineering	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development</li> <li>• To study Implications of 73<sup>rd</sup> CAA on Planning, Development and Governance of Rural Areas</li> <li>• 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</li> <li>• To understand the Nature and Type of Human Values relevant to Planning Institutions</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>• Apply knowledge for Rural Development.</li> <li>• Apply knowledge for Management Issues.</li> <li>• Apply knowledge for Initiatives and Strategies</li> <li>• Develop acumen for higher education and research.</li> <li>• Master the art of working in group of different nature.</li> <li>• Develop confidence to take up rural project activities independently</li> </ul>

Module	Contents	Hours
1	<b>Introduction to Rural Development:</b> 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	<b>Post-Independence Rural Development:</b> 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
3	<b>Rural Development Initiatives in Five Year Plans:</b> 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
4	<b>Post 73rd Amendment Scenario:</b> 73 <sup>rd</sup> 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	<b>Ethics:</b> Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

**References:**

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. Gol, Constitution (73<sup>rd</sup> Gol, New Delhi Amendment) Act, Gol, 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

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BML701	Biomedical Instrumentation – III Lab	--	2	--	1	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML701	Biomedical Instrumentation – III Lab	25		25	50

Course Code	Course Name	Credits
<b>BML701</b>	<b>Biomedical Instrumentation- -III</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles and working of life Saving Equipment.</li> <li>• To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>• To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcomes</b>	<b>Learner will be able to...</b> <ul style="list-style-type: none"> <li>• Design and implement basic Pacemaker circuits.</li> <li>• Design and implement basic oscillator circuits for Surgical Diathermy.</li> <li>• Demonstrate the knowledge of application techniques of physiotherapy machines.</li> <li>• Demonstrate the knowledge of application technique of oximeter</li> </ul>	

**Syllabus: Same as that of (Course Code) Biomedical Instrumentation- -III (BMI-III)**

### 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 Ultrasonic Diathermy
9. Demonstration of Nerve and Muscle Stimulator
10. Demonstration of Oximeter.
11. 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.

### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork and minimum passing in the ISA.

### 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: Leslie 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 entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BML702	Machine Learning Lab	--	2	--	1	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML702	Machine Learning Lab	25		25	50

BMC702	Machine Learning	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in artificial intelligence through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> <li>To train and motivate for higher education and research in order to make contribution to state of the art health care for all</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in neural networks, deep learning and machine learning</li> <li>Understand supervised and unsupervised learning, back propagation and gradient descent algorithms</li> <li>Understand and implement efficient computational techniques using neural networks, deep learning and machine learning</li> <li>Design and implementation of neural network models with deep learning and machine learning will be strong base for designing artificial intelligent systems</li> </ul>	

**Syllabus:** Same as that of (BMC702) Machine Learning (ML)

**List of Experiments:** (Any Seven)

- 1 Implement the activation functions used in the neural network
- 2 Implement ANDNOT and XOR function using McCulloch-Pitts neural net
- 3 Implementation of learning rules for neural network
- 4 Implementation of backpropagation with gradient descent algorithm neural network
- 5 Design and implement the neural network model for estimation problem.
- 6 Design and implement the neural network model for classification problem
- 7 Optimize the neural network model for estimation problem.
- 8 Optimize the neural network model for classification problem.
- 9 Design and implement the neural network model for estimation problem with deep learning
- 10 Design and implement the neural network model for estimation problem with deep learning

Any other experiment based on syllabus which will help learner to understand topic/concept.

#### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.

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

#### **Text books**

1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning Private Limited, New Delhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., Gravenstein Highway North, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, Prentice Hall, 2009

#### **Reference books**

1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education (India) Private Limited New Delhi, 2013

**Practical examination will be based on experiments and related topics in the laboratory sessions.**



Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7011	Biological Modelling and Simulation Lab (Abbreviated as BMS Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL7011	Biological Modelling and Simulation Lab	25		25	50

Course Code	Course Name	Credits
BMDL7011	Biological Modelling and Simulation Lab	01
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand basic approach of modeling for designing biological model.</li> <li>To simulate physiological processes for better understanding.</li> <li>To develop competency in terms of logical thinking, programming and application skills</li> <li>To train and motivate students for pursuing higher education and research for developing cutting edge technologies.</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Apply concept of physiological modelling to model thermometer system.</li> <li>Virtually understand biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions.</li> <li>Simulate mathematical model for the eye movement</li> <li>Electrically simulate model of thermoregulatory system</li> <li>Understand the usage of, and the assumptions behind biological models</li> </ul>	

### List of Laboratory Experiments (Any Seven)

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB(**Two practicals**)
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.

### In Semester Assessment(ISA):

ISA shall consist of minimum 7 experiments.

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

### 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 entire syllabus.**

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7012	Bioinformatics Lab (Abbreviated as BI Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL7012	Bioinformatics Lab	25		25	50

Course Code	Course Name	Credits
BML7012	Bioinformatics Lab	01
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>The course introduces the students to the field of Bioinformatics.</li> <li>To make students aware about the methods to characterise and manage the different types of biological data.</li> <li>To introduce students to the basics of sequence alignment and analysis.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to</b></p> <ul style="list-style-type: none"> <li>Get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.</li> <li>Apply knowledge of basic principles of mathematics and statistics.</li> <li>Apply existing software effectively to extract information from large databases and to use this information in computer modelling</li> <li>Apply problem-solving skills to multivariate methods in bioinformatics Search and apply bioinformatics tools to analyse and interpret biological data</li> </ul>	

**Syllabus: Same as that of BMD07012 Bioinformatics**

**List of Tutorials: (any seven Tutorials based on following topics)**

1. Steps in DNA sequencing
2. Different methods of DNA sequencing
3. Discovery of Gene Sequence.
4. Types of Proteomics
5. Mendel's postulates and laws of inheritance
6. Steps of dynamic programming
7. Classification of biological databases
8. Steps in Hypothesis Testing
9. Types of statistical models
10. Important Algorithms in Bioinformatics

Any other tutorial based on syllabus may be included, which would help the learner to understand topic/concept. A power point presentation on any of the topics in syllabus should be carried out.

**In Semester Assessment (ISA):**

ISA shall consist of minimum 7 tutorials.

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

**Books Recommended:***Text books:*

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

*Reference Books:*

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

**Oral examination will be based on entire syllabus.**

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7013	IOT Based Systems Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL7013	IOT Based Systems Lab	25		25	50

Course Code	Course Name	Credits
BMDL7013	IOT Based Systems Lab	01
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Learn the concepts of IOT</li> <li>Identify different technologies and schemes</li> <li>Learn different applications in IOT</li> <li>Learn different protocols used in IOT</li> <li>Learn how to analyze the data in IOT</li> </ul>	
<ul style="list-style-type: none"> <li><b>Course Outcomes</b></li> </ul>	<b>Learner will be able to</b> <ul style="list-style-type: none"> <li>Apply the concepts of IOT</li> <li>Identify and select different technologies and scheme for IOT applications</li> <li>Apply IOT to different applications</li> <li>Analyze and evaluate protocols used in IOT systems</li> <li>Analyze dataflow in IOT systems</li> </ul>	

**Syllabus: Same as that of (Course Code) Bioinformatics**

**List of Experiments: (any seven Experiments based on following list)**

- 1) To demonstrate I/O operations, interrupts, ADC and other onboard features using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).
- 2) To demonstrate interfacing various sensors and storing data on-board [ and on-board processing of data] using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).

- 3) To demonstrate interfacing various sensors and communicating data using Internet using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).
- 4) To demonstrate CoAP protocol (client – server model) with SOC platform as server.
- 5) To demonstrate CoAP protocol (client – server model) with SOC platform as client.
- 6) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as broker.
- 7) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as publisher.
- 8) To demonstrate the use of cloud storage.
- 9) To demonstrate the use/role of cloud computing.

Any other Experiment based on syllabus may be included, which would help the learner to understand topic/concept.

### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 tutorials.

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

### **Books Recommended:**

#### **Books Recommended:**

##### *Text books:*

1. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universities press.
2. IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
3. Data and Computer communications, William Stallings, Pearson Education.
4. Data communication and networking, Behrouz A. Forouzan, McGraw Hill Education  
Communication Networks, Alberto Leon Garcia, McGraw Hill Education.

##### *Reference Books:*

1. Computer Networks, S. Tanenbaum, Pearson Education.
2. Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, Addison Wesley.

**Oral examination will be based on entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BMP701	Major Project - I	--	6 <sup>#</sup>	--	3	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMP701	Major Project - I	25		25	50

Course Code	Course Name	Credits
<b>BMP701</b>	<b>Major Project-I</b>	<b>03</b>
<b>Course objective</b>	<ul style="list-style-type: none"> <li>To apply the knowledge gained during Curriculum to develop and design problem statement.</li> <li>Conduct literature survey.</li> <li>Design Circuit/ Flow chart of the statement.</li> <li>Documentation and project report writing.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to</b></p> <ul style="list-style-type: none"> <li>Review literature to define problem statement</li> <li>Apply knowledge of the engineering fundamentals acquired during the curriculum and beyond</li> <li>Develop and create design using appropriate design methodologies considering the various health, society and environmental needs.</li> <li>Write problem statement, Design concept in prescribed format.</li> <li>Learn the behavioral science by working in a group.</li> </ul>	

#### Project Guidelines:

- Learner is allotted 6 hrs per week for the project work
- Learners should carry out literature survey /visit industry / analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor.
- Group of maximum four students will be completing a comprehensive project work.
- Learners should use multiple literatures and understand the problem.
- Learners should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and compile the report in standard format
- 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

**In Semester Assessment (ISA):**

ISA 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



Semester – VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC801	Hospital Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC801	Hospital Management	20	30	50	100

Course Code	Course Name	Credits
<b>BMC801</b>	<b>Hospital Management</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles used for designing of various departments in the hospital.</li> <li>• To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.</li> <li>• To understand the overall functioning of various departments in the hospital.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Apply the management concepts used specifically in hospital.</li> <li>• Explain the management structure and its functions in hospital.</li> <li>• Demonstrate the knowledge about the principles of designing and commissioning of clinical services in the hospital.</li> <li>• Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital.</li> <li>• Demonstrate the knowledge about the functions of other Engineering and auxiliary services in the hospital.</li> <li>• Apply environment and waste management concepts in healthcare industry.</li> </ul>	

Module	Contents	Hours
1	<b>Process of management:</b> Principles of management, leadership, motivation, time management, H.R. management (recruitment, performance appraisal, training and development,), effective communication, accounting - types of Budget.	07
2	<b>Organization of the hospital and hospital planning:</b> 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	04
3	<b>Clinical services: (Location, layout, equipment, personnel, and functions):</b> OUT patient, IN patient (wards), intensive care, pathology laboratory & blood bank, radiology, physiotherapy, surgical operation theatre, emergency (casualty).	10
4	<b>Biomedical engineering department: (Location, layout, equipment, personnel, and its main functions)</b> Roles and responsibilities of a biomedical engineer in hospitals, Equipment management: maintenance types: routine(preventive) and breakdown, maintenance contracts (CMC and AMC) Purchase management: Purchase system (centralized, decentralized, local purchase), types of purchase, purchase procedures: selection of suppliers, tendering procedures, analyzing bids, price negotiations Material's (store) management: Functions of store manager, materials handling, flow of goods/FIFO, inventory control: lead-time, buffer stock, reorder level, two bin system, EOQ	09
5	<b>Other engineering services:</b> Engineering services (electrical, mechanical and civil): responsibilities and functions. Hospital ventilation and air conditioning, medical gas system, hospital information system.	05
6	<b>Environment and waste management:</b> Hospital infection control, central sterile service department (CSSD), biomedical waste management, disaster management.	04

### Books Recommended:

#### Text Books:

1. Hospital Management by Dr. Pradya 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
BMDO8011	Department Optional Course –5 Robotics In Medicine (Abbreviated as RIM)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8011	Department Optional Course –5 Robotics In Medicine (Abbreviated as RIM)	20	30	50	100

Course Code	Course Name	Credits
BMDO8011	Robotics In Medicine	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make the learner aware of fundamental concepts of Robotics</li> <li>To make learner study direct and Inverse Kinematics of Robots</li> <li>To make learner know the Trajectory and Motion planning.</li> <li>To make the learner know the Biomedical applications of robotics</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>To describe direct and inverse kinematics of robots.</li> <li>To describe workspace envelop and trajectory planning for robots</li> <li>To apply various image processing tools for robotic manipulation</li> <li>To implement motion planning solutions using various algorithms</li> <li>To illustrate medical applications of robots</li> </ul>	

Module No.	Contents	Hours
1	<b>Introduction:</b> Automation and robots, classification, application, specification and notations.	04
2	<b>Direct Kinematics:</b> Dot and cross products, co-ordinate frames, rotations, homogeneous coordinates, link co-ordinates, arm equation and arm matrix derivation (two axis, three axis and	10

	four axis SCARA), configuration of five axis and six axis robots (arm matrix derivation and equation not expected)	
<b>3</b>	<p><b>Inverse kinematics:</b></p> <p>General properties of solutions of inverse kinematics, methods for finding solution, tool configuration vector and inverse kinematics solution for two axis, three axis and four axis robots.</p> <p>Workspace analysis, work envelope and examples, workspace fixtures, trajectory planning, pick and place operations, continuous path motion, interpolated motion, straight-line motion.</p>	<b>08</b>
<b>4</b>	<p><b>Robot vision:</b></p> <p>Image representation, template matching, polyhedral objects, shape analysis, segmentation (thresholding, region labelling, shrink operators, swell operators, Euler numbers, perspective transformation, structured illumination, camera calibration).</p>	<b>06</b>
<b>5</b>	<p><b>Task planning:</b></p> <p>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.</p>	<b>06</b>
<b>6</b>	<p><b>Applications in biomedical engineering:</b></p> <p>Application in rehabilitation: clinical and surgery</p>	<b>05</b>

### Books Recommended:

#### Text Books:

1. Fundamentals of Robotics-Analysis and control, Robert Shilling, Prentice Hall of India
2. Introduction to Robotics, Saeed B Niku, Pearson Education
3. Robotics, Fu, Gonzales and Lee, McGraw Hill, Second Edition, 2011
4. "Introduction to Robotics-Mechanics & Control" John J. Craig, Pearson Education, India, Third Edition, 2009

#### 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, Mc Graw Hill, NewYork, 2008
4. Robot Engineering, Klafter, Chmielewski, Negin. Prentice Hall Of India.
5. Robotics and Control. Mittal, Nagrath, Tata McGraw Hill publications

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut	Total
BMDO8012	Department Optional Course –5 Healthcare Informatics (Abbreviated as HCI)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8012	Department Optional Course –5 Healthcare Informatics (Abbreviated as HCI)	20	30	50	100

Course Code	Course Name	Credits
BMDO8012	Healthcare Informatics	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the healthcare interoperability semantic and syntactic.</li> <li>To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learners will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand Healthcare interoperability standards</li> <li>Fabricate HL7 Messages</li> <li>Understand and Design UML Diagrams</li> <li>Understand semantic interoperability through DICOM</li> <li>Edit and Compare DICOM file</li> </ul>	

Module	Contents	Hours
1	<b>Healthcare interoperability:</b> Standards in healthcare system, categorizing standards, standard development, various healthcare informatics standards, need for a Lingua Franca, electronic health records, interoperability modelling basics.	05
2	<b>HL7 Version 2 (Part-I)</b> Message syntax, delimiters, segment definition, message header MSH, patient identification details (PID), patient visit (PV1), request and specimen details (OBR), result details (OBX).	04
3	<b>HL7 Version 2 (Part-II)</b> Z-Segments, data, simple data types, complex data types, codes and identifiers, names and addresses, other complex data types.	04
4	<b>DICOM standard:</b> Introduction, DICOM Grammar: VRs, DICOM data dictionary, DICOM objects, DICOM information hierarchy, modules, IODs and IEs.	07
5	<b>DICOM Communications:</b> 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.	09
6	<b>DICOM Associations</b> Association establishment, transfer syntax, application context, <b>DICOM Media: Files, Folders, and DICOMDIRs</b> DICOM File format, DICOM file services, storing DICOM data in PACS.	10

### Books Recommended:

#### *Textbooks:*

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pianykh, Springer Publication.
3. The CDATM 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
<b>BMDO8013</b>	<b>Department Optional Course –5 Artificial Intelligence in Medicine (Abbreviated as AIM)</b>	<b>03</b>	<b>--</b>	<b>--</b>	<b>03</b>	<b>--</b>	<b>--</b>	<b>03</b>

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8013	Department Optional Course –5 Artificial Intelligence in Medicine (Abbreviated as AIM)	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO8013</b>	<b>Artificial Intelligence in Medicine</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand basics of Artificial Intelligence, Intelligent Agents.</li> <li>• To conceptualize search techniques.</li> <li>• To understand expert system in Artificial Intelligence</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Develop a basic understanding of intelligent agents in artificial intelligence</li> <li>• Choose an appropriate problem-solving method and knowledge representation technique</li> <li>• Comprehend the concept of propositional logic</li> <li>• Understand Reasoning and Knowledge Representation</li> <li>• Develop basic understanding of expert system and it's applications</li> <li>• Learn AI applications in health care</li> </ul>	

Module	Contents	Hours
1	<b>Basics of Artificial Intelligent:</b> Definition and concept of Artificial Intelligence, stages of AI, intelligent agents in artificial intelligence, foundations of AI and applications, current trends in AI	04
2	<b>Problem Spaces, and Search:</b> Breadth first search, depth first search techniques, iterative deepening, bidirectional search, best first search, Heuristic search, Hill Climbing, A* Search, <b>Problem reduction and game playing:</b> Introduction, problem reduction, game playing, alphabeta pruning, two-player perfect information games	10
3	<b>Logic concepts:</b> Introduction, propositional calculus, propositional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic	07
4	<b>Knowledge Representation:</b> Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, inferencing, monotonic and non-monotonic reasoning.	08
5	<b>Expert system and applications:</b> Introduction phases in building expert systems, expert system versus traditional systems, rule-based expert systems blackboard systems truth maintenance systems,application of expert systems	06
6	<b>AI in Healthcare:</b> Benefits of AI in medicine, AI and Medical visualization, Medical Expert system, Applying AI to EHR Data, Artificial Intelligence in Medical Imaging	04

### Books Recommended:

#### Text Books:

- 1 Stuart J. Russell and Peter Norvig, "**Artificial Intelligence: A Modern Approach**", Fourth Edition" Pearson Education, 2020.
- 2 Saroj Kaushik, "**Artificial Intelligence**", Cengage Learning, First edition, 2011
- 3 Itisha Gupta and Garima Nagpal, "**Artificial Intelligence and Expert System**", Laxmi Publications, 1st Edition 2018

#### Reference Books:

- 1 Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.



- 2 Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
- 3 Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
- 4 Elaine Rich and Kevin Knight, "**Artificial Intelligence**", Third Edition, McGraw Hill Education, 2017.

#### Useful Links:

- 1 <https://nptel.ac.in/courses/106/105/106105078/>
- 2 <https://archive.nptel.ac.in/courses/106/105/106105077/#>
- 3 <https://nptel.ac.in/courses/106/105/106105079/>

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8021	Department Optional Course –6 Biomedical Microsystems (Abbreviated as BM)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8021	Department Optional Course –6 Biomedical Microsystems (Abbreviated as BM)	20	30	50	100

Course Code	Course Name	Credits
BMDO8021	Biomedical Microsystems	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand various fabrication techniques for MEMS devices.</li> <li>To apply the knowledge of MEMS in Biomedical field.</li> <li>To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand basic property and select appropriate material for MEMS application</li> <li>Develop or modify the MEMS processes for a simple MEMS device in order to reduce the fabrication time.</li> <li>Understand different microfabrication techniques and choose appropriate technique</li> <li>Analyse Micro total analysis system with designing of its components</li> <li>Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication</li> <li>Understand packaging techniques used in MEMS</li> </ul>	

Module	Contents	Hours
1.	<p><b>Introduction to miniaturization:</b></p> <ul style="list-style-type: none"> <li>• Difference between Microelectronics and MEMs, Block diagram of MEMS and BIOMEMS, examples. Introduction to generalised processes used.</li> <li>• Clean room: definition, classification, air flow system</li> <li>• Safety in handling hazardous materials in clean room</li> <li>• Scaling Laws in Miniaturization</li> <li>• Substrates and Wafers: CZ process and float zone process, Wafer types</li> <li>• Materials: Properties and applications of single crystal silicon, SiO<sub>2</sub>, Si<sub>3</sub>N<sub>4</sub>, SiC, Polysilicon, Glass</li> <li>• Wafer cleaning processes: RCA, Piranha</li> <li>• Positive and negative photoresist, mask, material properties of PMMA, SU8</li> <li>• Different projection systems,</li> <li>• Surface characterization techniques: AFM, SEM, TEM, Ellipsometer, Profilometer</li> </ul>	06
2.	<p><b>MEMS Fabrication Processes</b></p> <ul style="list-style-type: none"> <li>• Photolithography: Definition, steps, light sources (UV, DUV, EUV)</li> <li>• PVD: definition, types: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), advantages, disadvantages, Material properties of Al</li> <li>• CVD: definition, reaction steps, types: APCVD, LPCVD, PECVD, and HWCVD, advantages, disadvantages</li> <li>• Oxidation: Thermal</li> <li>• Polymers coating techniques: spinning, spraying and electrodeposition</li> <li>• Doping: definition, types: Ion implantation and Diffusion, advantages, disadvantages</li> <li>• Etching: types: Dry etching (RIE, DRIE) and wet etching (isotropic and anisotropic), advantages, disadvantages, specific etchants</li> </ul>	07
3.	<p><b>Microfabrication Techniques</b></p> <ul style="list-style-type: none"> <li>• Bulk micromachining: definition, advantages and disadvantages, Examples: pressure sensor, dissolved wafer process</li> <li>• Surface micromachining: definition, advantages and disadvantages Examples: pressure sensor, cantilever</li> <li>• Non polysilicon surface micromachining: SOI fabrication</li> <li>• LIGA: definition, process steps, examples, advantages and disadvantages</li> <li>• X-ray lithography: Synchrotron radiation, X-ray mask</li> <li>• Molding techniques: Injection, compression, hot embossing</li> <li>• Soft lithography: Definition, SAMs, Types: Micro Contact Printing, Material properties of PDMS, Gold, Conducting polymers</li> <li>• Micro molding techniques: Replica molding, Microtransfer molding, Micromolding in capillaries and Solvent-assisted micromolding</li> </ul>	07

4.	<b>MICRO TOTAL ANALYSIS SYSTEMS (<math>\mu</math>TAS)</b> <ul style="list-style-type: none"> <li>• Flow techniques in <math>\mu</math>-fluidics: pressure driven force, electro-osmosis, electrophoresis</li> <li>• Micropump, microvalves: types and fabrication</li> <li>• Microchannels: Types and fabrication (SU8, glass, silicon)</li> </ul>	<b>07</b>
	<ul style="list-style-type: none"> <li>• Separation techniques: capillary electrophoresis, electrochromatography, isoelectric focusing</li> <li>• Detection techniques: fluorescence, chemiluminescence</li> </ul>	
5.	<b>MICRO/ NANO BIOSENSORS AND DRUG DELIVERY DEVICES</b> <ul style="list-style-type: none"> <li>• Biosensor: definition, block diagram</li> <li>• Classification based on the basis of detection techniques: electric, magnetic, optical, thermal, mechanical, and chemical</li> <li>• Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer</li> <li>• Design, fabrication of cantilever for antibody detection</li> <li>• Hypodermic needles, transdermal patches: disadvantages</li> <li>• Micro needles: solid, hollow, polymer, silicon (fabrication)</li> <li>• Nano particles for drug delivery</li> </ul>	<b>06</b>
6	<b>MICROSYSTEM PACKAGING</b> <ul style="list-style-type: none"> <li>• Packaging materials</li> <li>• Levels of packaging</li> <li>• Comparison between IC and MEMS packaging</li> <li>• Packaging technologies: Die preparation, surface bonding, wire bonding, sealing</li> <li>• Pressure sensor packaging</li> </ul>	<b>06</b>

#### 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, O. 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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8022	Medical Devices Regulations (Abbreviated as MDR)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8022	Medical Devices Regulations (Abbreviated as MDR)	20	30	50	100

Course Code	Course Name	Credits
BMDO8022	Medical Devices Regulations	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the learners with the regulatory aspects of medical devices and instruments.</li> <li>To keep the learners abreast with the technological developments in the field of Medical devices regulatory affairs.</li> </ul>	
<b>Course Outcomes</b>	<p>Learner will be able to:</p> <ul style="list-style-type: none"> <li>Discuss credibility &amp; authorities of approvals, medical devices life cycle, risk based classification and risk based approach for regulatory controls.</li> <li>Explain principles of safety and effectiveness, quality management system, Various standards (American, European, BIS), risk management, cyber security and clinical evaluation.</li> <li>Describe technical documentation required by regulators, essential requirements checklist, risk management summary report, manufacturing information, regulated product submissions and regulatory submission repository.</li> <li>Highlight premarket phase like design controls, information management during premarket phase, R&amp;D planning stage, design &amp; development process stage and product identification &amp; traceability.</li> <li>Perform regulatory submissions, approvals and registration.</li> <li>Launch the product, do post market surveillance, look after product obsolescence, oversee quality management system and regulatory system &amp; processes.</li> </ul>	

Module	Contents	Hours
1.	<b>Overview of regulatory framework for medical devices:</b> Credibility and authority of approvals, medical devices life cycle, risk-based classification, risk-based approach for regulatory controls. Introduction to International Regulatory Requirements & Device Pathways.	07
2.	<b>Safety &amp; Effectiveness:</b> Principles of safety and effectiveness, Quality management system, Standards, Risk management, Cybersecurity, Clinical evaluation. Classification of Biomedical Instruments, based on safety standards, Approach to Bioethics	07
3.	<b>Technical Documentation:</b> Technical documentation required by regulators, Essential requirements checklist, Risk management summary report, Manufacturing information, Regulated product submissions, Regulatory submission repository	07
4.	<b>Premarket phase:</b> Design controls, Information management during premarket phase, R&D planning stage, Design & development process stage, product identification & traceability, Case study	06
5.	<b>Regulatory submissions, approvals and registration:</b> Administrative provisions, regulatory submission and approval, International scenario	06
6.	<b>Post market phase:</b> Product launch, continued regulatory compliance, Post market surveillance, Product obsolescence, Quality management system, Regulatory system, and processes. Types of medical device audits. Medical device Compliance Audit	06

### Books Recommended:

#### Textbooks:

1. Medical device regulatory practices, Val Theisz, PAN Satnford Publishing
2. Handbook of Medical Device regulatory affairs in Asia, edited by Jack Wong and Raymond KYTong
3. Medical Device Regulations: Global Overview and Guiding Principles, Michael Cheng, WorldHealth Organization.

#### Reference Books:

1. Daniel A. Vallero - Biomedical Ethics for Engineers\_ Ethics and Decision Making in Biomedical and Biosystem Engineering (Biomedical Engineering Series)-Academic Press
2. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
3. Ethics for Biomedical Engineers, Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley, Winston Gwee, Dennis Kwok-Wing Tam (auth.) , Springer-Verlag New York

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8023	Department Optional Course –6 Ergonomics (Abbreviated as ERG)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO8023	Department Optional Course –6 Ergonomics (Abbreviated as ERG)	20	30	50	100

Course Code	Course Name	Credits
BMDO8023	Ergonomics	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand various fabrication techniques for MEMS devices.</li> <li>To apply the knowledge of MEMS in Biomedical field.</li> <li>To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand basic property and select appropriate material for MEMS application</li> <li>Develop or modify the MEMS processes for a simple MEMS device in order to reduce the fabrication time.</li> <li>Understand different microfabrication techniques and choose appropriate technique</li> <li>Analyse Micro total analysis system with designing of its components</li> <li>Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication</li> <li>Understand packaging techniques used in MEMS</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Ergonomics</b> <ul style="list-style-type: none"> <li>• Definition of Ergonomics and its application and overview.</li> <li>• Ergonomics in systems design, and steps to performing a task analysis. In class practice performing a task analysis.</li> </ul>	08
2.	<b>Design Man Machine Environment System Design</b> <ul style="list-style-type: none"> <li>• Overview of Human body and its sub systems.</li> <li>• Understanding musculoskeletal system and its function in terms of manual activities</li> <li>• Understanding nervous system, human sensory organs and their limitations.</li> <li>• Basic Bio mechanics and its application in design</li> </ul>	09
3.	<b>Muscle Use and Anthropometry and Workspace</b> <ul style="list-style-type: none"> <li>• Anthropometry and its application</li> <li>• Issues of cognition, perception and performance.</li> <li>• Study of work posture and its impact on human performance.</li> <li>• Physical environment and their impact on human performance</li> <li>• Muscular work including dynamic and static work, nervous control of movement, skilled work and ways to improve work efficiency.</li> <li>• Use of anthropometric data in ergonomics.</li> <li>• Principles of workspace design, including seated work, standing work, work reaches and working heights, the office environment and visual work</li> </ul>	10
4.	<b>Occupational stress and Musculoskeletal disorders; Safety and health issues</b> <b>Cognitive aspects of user-system interaction:</b> <ul style="list-style-type: none"> <li>• Perception, information processing, user behaviour, error and risk perception;</li> </ul>	04
5.	<b>Principles of human factors in visual communication</b> <ul style="list-style-type: none"> <li>• Visual display in different planes- static shape, size, font type and dynamic characters of display</li> </ul>	04
6	<b>Environmental factors influencing human performance</b> <ul style="list-style-type: none"> <li>• Participatory ergonomics aspects</li> </ul>	04

#### Books Recommended:

##### Text Books:

1. Bridger, R., Introduction to Ergonomics, 3rd Ed., CRC Press, Taylor & Francis Group, 2009.
2. Sanders, M., McCormick, E., Human Factors in Engineering and Design, 7th Ed., McGraw-Hill International Editions: Psychology Series, 2013
3. Wicknes, C., Gordon, S., Liu, Y., and Gordon-Becker, S., An Introduction to Human Factors Engineering, Longman, New York, 2015
4. Chakrabarti, D., Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997
5. Salvendy, G. (ed.), Handbook of Human Factors and ergonomics, 4th Ed., John Wiley & Sons, Inc., 2012



6. Dul, J., Weerdmeester, B., Ergonomics for beginners, a quick reference guide, 3rd Ed., CRC Press, Taylor & Francis Group, 2008.

#### Reference Books:

1. J. Dul, and B. Weerdmeester, Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.
2. E. Grandjean : Fitting the task to the man, Taylor & Francis Ltd. 1980.
3. J. Ansel, Visual ergonomics in the workplace, Taylor & Francis, London, 1998
4. W. Karwowski and W. S. Marras, The Occupational Ergonomics handbook, CRC Press, New York, 1999.
5. M. S. Sanders and E. J. McCormick, Human Factors in Engineering and Design, McGraw-Hill, Inc., 1993.
6. K. Kroemer, H. B. Kroemer and K. E. Kroemer, Ergonomics- How to Design for Easy and Efficiency, Prentice Hall Englewood Cliffs, NJ 07632, 1994.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8021	Project Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO 8021	Project Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>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.</li> <li>To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Apply selection criteria and select an appropriate project from different options.</li> <li>Write work break down structure for a project and develop a schedule based on it.</li> <li>Identify opportunities and threats to the project and decide an approach to deal with them strategically.</li> <li>Use Earned value technique and determine &amp; predict status of the project.</li> <li>Capture lessons learned during project phases and document them for future reference</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Project Management Foundation:</b>            Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical &amp; atypical) Project phases and stagegate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)</p>	05
2	<p><b>Initiating Projects:</b>            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 &amp; growth (forming, storming, norming &amp; performing), team dynamics.</p>	06

3	<p><b>Project Planning and Scheduling:</b>  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).</p>	08
4	<p>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</p>	06
5	<p><b>5.1</b> Executing Projects:  Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings  <b>5.2</b> 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  <b>5.3</b> Project Contracting  Project procurement management, contracting and outsourcing,</p>	08
6	<p>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.</p>	06

**REFERENCES:**

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7<sup>th</sup> Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9<sup>th</sup> Edition, Gower Publishing England

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8022	Finance Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO 8022	Finance Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>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.</li> <li>To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand Indian finance system and corporate finance</li> <li>Take investment, finance as well as dividend decisions</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
2	<p><b>Concepts of Returns and Risks:</b> 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.</p> <p><b>Time Value of Money:</b> 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.</p>	06

3	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> 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.</p>	09
4	<p><b>Capital Budgeting:</b> 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)</p> <p><b>Working Capital Management:</b> 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.</p>	10
5	<p><b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p><b>Capital Structure:</b> 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</p>	05
06	<p><b>Dividend Policy:</b> 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</p>	03

#### REFERENCES:

1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8023	<b>Entrepreneurship Development and Management</b>					
		<b>3</b>	<b>--</b>	<b>3</b>	<b>--</b>	<b>3</b>

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8023	Entrepreneurship Development and Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To acquaint with entrepreneurship and management of business</li> <li>Understand Indian environment for entrepreneurship</li> <li>Idea of EDP, MSME</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the concept of business plan and ownerships</li> <li>Interpret key regulations and legal aspects of entrepreneurship in India</li> <li>Understand government policies for entrepreneurs</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Overview of Entrepreneurship:</b> 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</p> <p>Role of Money and Capital Markets in Entrepreneurial Development:Contribution of Government Agencies in Sourcing information for Entrepreneurship</p>	04
2	<p><b>Business Plans and Importance of Capital to Entrepreneurship:</b> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing aswell as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks,Assumptions and Conclusion, Capital and its Importance to the Entrepreneur</p> <p><b>Entrepreneurship and Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations</p>	09
3	<p>Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises</p>	05

4	<b>Indian Environment for Entrepreneurship:</b> 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
5	<b>Effective Management of Business:</b> 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	<b>Achieving Success In The Small Business:</b> 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](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://www.msmetraining.gov.in)



Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8024	<b>Human Resource Management</b>	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8024	Human Resource Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To introduce the students with basic concepts, techniques and practices of the human resource management</li> <li>To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations</li> <li>To familiarize the students about the latest developments, trends &amp; different aspects of HRM</li> <li>To acquaint the student with the importance of inter-personal &amp; inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the concepts, aspects, techniques and practices of the human resource management.</li> <li>Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.</li> <li>Gain knowledge about the latest developments and trends in HRM.</li> <li>Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.</li> </ul>

Module	Detailed Contents	Hours
1	<p><b>Introduction to HR</b></p> <ul style="list-style-type: none"> <li>Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions</li> <li>Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues</li> </ul>	05
2	<p><b>Organizational Behaviour (OB)</b></p> <ul style="list-style-type: none"> <li>Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues</li> </ul>	07

	<ul style="list-style-type: none"> <li>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> <li>• Perception: Attitude and Value, Effect of perception on Individual Decision- making, Attitude and Behaviour</li> <li>• Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);</li> <li>• 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.</li> </ul> <p>Case study</p>	
3	<p><b>Organizational Structure &amp; Design</b></p> <ul style="list-style-type: none"> <li>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	06
4	<p><b>Human resource Planning</b></p> <ul style="list-style-type: none"> <li>• Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale</li> <li>• Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counselling, Career Planning</li> <li>• Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>	05
5	<p><b>Emerging Trends in HR</b></p> <ul style="list-style-type: none"> <li>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>• 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</li> </ul>	06
6	<p><b>HR &amp; MIS:</b> Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries)</p> <p><b>Strategic HRM:</b> 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</p> <p><b>Labor Laws &amp; Industrial Relations:</b> Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	10

#### REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup> edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial

- relations, 5<sup>th</sup> Ed,2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, 2016, Pearson Publications

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8025	<b>Professional Ethics and Corporate Social Responsibility (CSR)</b>	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand professional ethics in business</li> <li>To recognized corporate social responsibility</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand rights and duties of business</li> <li>Distinguish different aspects of corporate social responsibility</li> <li>Demonstrate professional ethics</li> <li>Understand legal aspects of corporate social responsibility</li> </ul>

Module	Detailed Contents	Hours
1	<b>Professional Ethics and Business:</b> 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	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
3	<b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy <b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06

4	<b>Introduction to Corporate Social Responsibility:</b> 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	<b>Corporate Social Responsibility:</b> 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
6	<b>Corporate Social Responsibility in Globalizing India:</b> 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; Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8026	Research Methodology	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8026	Research Methodology	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand Research and Research Process</li> <li>To acquaint students with identifying problems for research and develop research strategies</li> <li>To familiarize students with the techniques of data collection, analysis of data and interpretation</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Prepare a preliminary research design for projects in their subject matter areas</li> <li>Accurately collect, analyze and report data</li> <li>Present complex data or situations clearly</li> <li>Review and analyze research findings</li> </ul>

Module	Detailed Contents	Hours
01	<p><b>Introduction and Basic Research Concepts</b></p> <p><b>1.1</b> Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</p> <p><b>1.2</b> Need of Research in Business and Social Sciences</p> <p><b>1.3</b> Objectives of Research</p> <p><b>1.4</b> Issues and Problems in Research</p> <p><b>1.5</b> Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</p>	09
02	<p><b>Types of Research</b></p> <p><b>2.1.</b> Basic Research</p> <p><b>2.2.</b> Applied Research</p> <p><b>2.3.</b> Descriptive Research</p> <p><b>2.4.</b> Analytical Research</p> <p><b>2.5.</b> Empirical Research</p> <p><b>2.6</b> Qualitative and Quantitative Approaches</p>	07

03	<b>Research Design and Sample Design</b> <b>3.1</b> Research Design – Meaning, Types and Significance <b>3.2</b> Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	<b>Research Methodology</b> <b>4.1</b> Meaning of Research Methodology <b>4.2.</b> Stages in Scientific Research Process: <b>a.</b> Identification and Selection of Research Problem <b>b.</b> Formulation of Research Problem <b>c.</b> Review of Literature <b>d.</b> Formulation of Hypothesis <b>e.</b> Formulation of research Design <b>f.</b> Sample Design <b>g.</b> Data Collection <b>h.</b> Data Analysis <b>i.</b> Hypothesis testing and Interpretation of Data <b>j.</b> Preparation of Research Report	08
05	<b>Formulating Research Problem</b> <b>5.1</b> Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	<b>Outcome of Research</b> <b>6.1</b> Preparation of the report on conclusion reached <b>6.2</b> Validity Testing & Ethical Issues <b>6.3</b> Suggestions and Recommendation	04

#### REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS PublishersDistributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, WileyEastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed),Singapore, Pearson Education

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8027	IPR and Patenting	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8027	IPR and Patenting	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand intellectual property rights protection system</li> <li>To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures</li> <li>To get acquaintance with Patent search and patent filing procedure and applications</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>understand Intellectual Property assets</li> <li>assist individuals and organizations in capacity building</li> <li>work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting</li> </ul>

Module	Detailed Contents	Hours
01	<p><b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.</p> <p><b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</p>	05
02	<p><b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement</p> <p><b>Indian Scenario of IPR:</b> Introduction, History of IPR in India, Overview of IPR 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.</p>	07
03	<p><b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.</p>	05



04	<b>Basics of Patents:</b> 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, Patentspecification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	<b>Patent Rules:</b> Indian patent act, European scenario, US scenario, Australiascenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	<b>Procedure for Filing a Patent (National and International):</b> 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 <b>Patent databases:</b> 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, 7<sup>th</sup> Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, ExcelBooks
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, BSPublications
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	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8028	Digital Business Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO 8028	Digital BusinessManagement	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize with digital business concept</li> <li>To acquaint with E-commerce</li> <li>To give insights into E-business and its strategies</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Identify drivers of digital business</li> <li>Illustrate various approaches and techniques for E-business and management</li> <li>Prepare E-business plan</li> </ul>

Module	Detailed content	Hours
1	<p><b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts, Difference between physical economy and digital economy.</p> <p><b>Drivers of digital business-</b> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services), Opportunities and Challenges in Digital Business</p>	09
2	<p><b>Overview of E-Commerce</b></p> <p><b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>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</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p> <p>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</p>	06

3	<b>Digital Business Support services:</b> ERP as e –business backbone, knowledgeTope Apps, Information and referral system <b>Application Development:</b> Building Digital business Applications and infrastructure	06
4	<b>Managing E-Business-</b> 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	<b>E-Business Strategy-</b> 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	<b>Materializing e-business: From Idea to Realization-</b> Business plan preparation <b>Case Studies and presentations</b>	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, 6<sup>th</sup> 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, 2<sup>nd</sup> 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 2<sup>nd</sup> 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 (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8029	Environmental Management	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ILO8029	Environmental Management	20	30	50	100

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Understand and identify environmental issues relevant to India and global concerns</li> <li>Learn concepts of ecology</li> <li>Familiarise environment related legislations</li> </ul>
<b>Course Outcomes</b>	<p><b>Upon successful completion of this course, the learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Understand the concept of environmental management</li> <li>Understand ecosystem and interdependence, food chain etc.</li> <li>Understand and interpret environment related legislations</li> </ul>

Module	Detailed Contents	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 and 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

**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, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing, 2015

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML801	Hospital Management Lab	--	2	--	1	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML801	Hospital Management Lab	25		25	50

Course Code	Course Name	Credits
<b>BML801</b>	<b>Hospital Management</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles used for designing of various departments in the hospital.</li> <li>• To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.</li> <li>• To understand the overall functioning of various departments in the hospital.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Apply the management concepts used specifically in hospital.</li> <li>• Explain the management structure and its functions in hospital.</li> <li>• Demonstrate the knowledge about the principles of designing and commissioning of clinical services in the hospital.</li> <li>• Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital.</li> <li>• Demonstrate the knowledge about the functions of other Engineering and auxiliary services in the hospital.</li> <li>• Apply environment and waste management concepts in healthcare industry.</li> </ul>	

**Syllabus: Same as that of BMC801 Hospital Management (HM).**

**List of Experiments and Assignments: (Any Four Experiments and Any Four Assignments)**

1. Design of Registration form of hospital.
2. Prepare an organization chart for multi-speciality hospital
3. Prepare budget using EXCEL sheet for purchase of hospital equipment.
4. Preparation of Comparative Statement in Excel for purchase of medical equipment. **(Any Two)**
5. Design the layout of Outpatient Department in hospital.
6. Design the layout of ICU 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.

**Books Recommended:**

*Text Books:*

1. Hospital Management by Dr. Pradya Pai,
2. Hospital Planning, Designing and Management: Kundurs G D, Gopinath, A Katakam (Private PubBangalore)

*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 PubBangalore)
3. Careers in Biomedical: Shantanu Thatte.

**In Semester Assessment (ISA):**

ISA shall consist of minimum 4 experiments, 4 assignments and presentation.The

The final certification and acceptance of ISA 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
BMDL8011	Robotics In Medicine Laboratory (Abbreviated as RIM Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL8011	Robotics In Medicine Laboratory (Abbreviated as RIM Lab)	25		25	50

Course Code	Course Name	Credits
BMDL8011	Robotics In Medicine Laboratory	01
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make the learner aware of fundamental concepts of Robotics</li> <li>To make learner study direct and Inverse Kinematics of Robots</li> <li>To make learner know the Trajectory and Motion planning.</li> <li>To make the learner know the Biomedical applications of robotics</li> </ul>	
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>To describe direct and inverse kinematics of robots.</li> <li>To describe workspace envelop and trajectory planning for robots</li> <li>To apply various image processing tools for robotic manipulation</li> <li>To implement motion planning solutions using various algorithms</li> <li>To illustrate medical applications of robots</li> </ul>	

**Syllabus: Same as that of BMDO8011 Hospital Management (HM).**

#### List of Experiments: (Any Seven)

**Students can perform any other experiment/Mini project/ Seminar/ Scholarly paper review based on the theory syllabus. The coding can be done in MATLAB/SCILAB/Python/C**

1. Fundamental and Composite Rotations of Mobile frame with respect to fixed frame
2. Homogeneous Transformations and Screw Transformations
3. Kinematic configurations and Link Coordinate Transformations matrix(Arm Matrix)
4. Direct Kinematics of 2-3 axis Planar Robot and find the location of Tool tip.
5. Direct Kinematic Analysis of 4,5 Axis Robot
6. Inverse Kinematics of robots and prove that there are multiple ways to reach a particular point.
7. Develop Work Envelop for 2,3 axis Robot



8. To study segmentation using edge detection technique
9. Straight line trajectory planning-BDA Algorithm
10. Template Matching
11. Gross motion planning is a part of task planning of robot. Suggest any method of gross motion planning so that the task can be completed without hitting obstacles
12. Presentation/ Seminar/Case study on Biomedical Application of robotics

#### **In Semester Assessment(ISA):**

ISA shall consist of minimum 4 experiments, 4 assignments and presentation.The

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

**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
BMDL8012	Department Optional Course – 5 Lab Healthcare Informatics Laboratory (Abbreviated as HCI Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL8012	Department Optional Course – 5 Lab Healthcare Informatics Laboratory (Abbreviated as HCI Lab)	25		25	50

Course Code	Course Name	Credits
BMDL8012	Healthcare Informatics Laboratory	01
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the healthcare interoperability semantic and syntactic.</li> <li>To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages.</li> </ul>	
<b>Course Outcomes</b>	<b>Learners will be able to:</b> <ul style="list-style-type: none"> <li>Fabricate HL7 Messages</li> <li>Edit and Compare DICOM file.</li> </ul>	

**Syllabus: Same as that of BMD08012 Healthcare Informatics (HCI).**

#### List of Experiments: (Any Seven)

- To find term/ Concept and ID or Vocabulary codes.
- Identifying and Chapters of Health Level 7 for trigger Event and message types and message.
- Structure should be sent to cover each requirement.
- Reading and editing segment.
- Create Health Level 7 Message.
- Create Patient Information Database from Health Level 7 Messages.
- To Study DICOM Validation Tool (DVTK).
- Edit DICOM File using hex-Editor.
- Creating Database of a patient.
- Comparing DICOM file.

Any other experiment based on syllabus which will help learner to understand topic/concept.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 experiments.

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

**Books Recommended:***Textbooks:*

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pinykh, Springer Publication.
3. The CDATM 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
BMDL8013	Department Optional Course – 5 Lab Artificial Intelligence in Medicine (Abbreviated as AIM)	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDL8013	Department Optional Course – 5 Lab Artificial Intelligence in Medicine (Abbreviated as AIM)	25		25	50

Course Code	Course Name	Credits
BMDL8013	Artificial Intelligence in Medicine	01
Course Objectives	<ul style="list-style-type: none"> <li>To understand the basic techniques to build intelligent systems</li> <li>To apply appropriate search techniques used in problem solving</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Identify languages and technologies for Artificial Intelligence</li> <li>Understand and implement searching techniques</li> <li>Create a knowledge base</li> <li>Design and implement expert systems</li> </ul>	

## Suggested List of Experiments

Sr. No.	Title of Experiment
1.	Introduce AI programming language
2.	Knowledge representation and create knowledge base
3.	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.
4.	Assignments on State space formulation and PEAS representation for various AI applications
5.	Uninformed search methods.
6.	Informed search methods.
7.	Game playing algorithms.
8.	First order Logic

Note: Any other practical/assignments covering the syllabus topics and subtopics can be conducted.

### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

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

### Books Recommended:

#### *Text Books:*

- 1 Stuart J. Russell and Peter Norvig, "**Artificial Intelligence: A Modern Approach**", Fourth Edition" Pearson Education, 2020.
- 2 Saroj Kaushik, "**Artificial Intelligence**", Cengage Learning, First edition, 2011
- 3 Itisha Gupta and Garima Nagpal, "**Artificial Intelligence and Expert System**", Laxmi Publications, 1st Edition 2018

#### *Reference Books:*

- 1 Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
- 2 Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
- 3 Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
- 4 Elaine Rich and Kevin Knight, "**Artificial Intelligence**", Third Edition, McGraw Hill Education, 2017.

**Oral examination will be based on suggested practical list and entire syllabus**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMP801	Major Project - II	--	12 <sup>#</sup>	--	6	6

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMP801	Major Project - II	100		50	150

Course Code	Course Name	Credits
<b>BMP801</b>	<b>Major Project-II</b>	<b>06</b>
<b>Course objective</b>	<ul style="list-style-type: none"> <li>• Implement the concept of Project Stage-I</li> <li>• Use advanced tools for Implementation</li> <li>• Rectify/ Debug the design and Submit project report.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to</b></p> <ul style="list-style-type: none"> <li>• Debug/ Rectify the design incurred during implementation</li> <li>• Write Analysis, Results, Design in prescribed format</li> <li>• Learn the behavioural science by working in a group</li> </ul>	

#### Project 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.

## In Semester Assessment (ISA):

The ISA 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