Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Electronics and Computer Science

Third Year Scheme & Syllabus

(As per AICTE guidelines, with effect from the 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)**. The 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 begin 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 learners 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 Honours/Minor 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 Electronics and Computer Science
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Third Year B. Tech. Electronics and Computer Science **Semester: V**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
HS04	Presentation Skills	Practical	1	50	-	-	050
BS12	Engineering Mathematics-V	Theory	3	20	30	50	100
EC10T	Basic VLSI Design	Theory	2	15	20	40	075
EC10P	Basic VLSI Design Lab	Practical	1	25	-	25	050
EC11T	Microcontroller and Applications	Theory	2	15	20	40	075
EC11P	Microcontroller and Applications Lab	Practical	1	25	-	25	050
EC12T	Operating System	Theory	2	15	20	40	075
EC12P	Operating System Lab	Practical	1	25	-	25	050
EC13T	Analysis of Algorithms	Theory	2	15	20	40	075
EC13P	Analysis of Algorithms Lab	Practical	1	25	-	25	050
ECXXT	Professional Elective-1	Theory	2	15	20	40	075
ECXXP	Professional Elective-1 Lab	Practical	1	25	-	25	050
EC45	Mini Project	Practical	2	25	-	50	075
GE01$	Internship with other Institutes (Credit Transfer)	Theory	4	As Per Course (During Summer Break of Sem 4 & Sem 5)			125

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

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.

Guidelines for Professional Elective Courses and Specialization Certificate – Refer Appendix-A

Important Note 1: Learners are required to go through Appendix-A carefully before selecting the Professional Elective courses. Detailed guidelines regarding Professional Elective courses, specialization tracks and courses relevant to each track are given in Appendix-A.

Professional Elective -1 Courses (ECXX)

Course Code	Course Name	Specialization Track Name#
EC21T	Artificial Intelligence	Artificial Intelligence & Machine Learning
EC21P	Artificial Intelligence lab	
EC22T	Advanced Database Management	Data Analytics
EC22P	Advanced Database Management Lab	
EC23T	Modern Sensors for IOT	Internet of Things
EC23P	Modern Sensors for IOT Lab	
EC24T	Digital System Design	VLSI
EC24P	Digital System Design Lab	

#For details of Specialization Certificate, refer Appendix-A

Guidelines for Award of Honours/ Minor Degree – Refer Appendix-B

Important Note 2: Before the end of Semester 5, learners are required to go through the Appendix-B carefully to opt for Honours/ Minor Degree Programme. Learners willing to opt for Honours/ Minor Degree Programme are required to satisfactorily complete the course titled "Industry Interaction" of 1 credit preferably during the break of the semester 5 and semester 6 which will facilitate them to select Honours/ Minor Degree Programme of their choice. Detailed guidelines regarding the Honours/ Minor Degree Programmes of all the departments, Eligibility criterion and Credit requirements are given in Appendix-B. Courses relevant to Honours/ Minor Degree Programmes offered by Department of Electronics and Computer Science are given in Appendix-C.

Third Year B. Tech. Electronics and Computer Science **Semester: VI**

Course Structure and Assessment Guidelines

Course		Head of Learning	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
EC14T	Digital Image Processing	Theory	2	15	20	40	075
EC14P	Digital Image Processing Lab	Practical	1	25	-	25	050
EC15T	Theory of Computer Science	Theory + Tutorial	3	40	20	40	100
EC16T	Computer Networks	Theory	2	15	20	40	075
EC16P	Computer Networks Lab	Practical	1	25	-	25	050
EC17T	Analog & Digital Communications	Theory	2	15	20	40	075
EC17P	Analog & Digital Communications Lab	Practical	1	25	-	25	050
ECXXT	Professional Elective-2	Theory	2	15	20	40	075
ECXXP	Professional Elective-2 Lab	Practical	1	25	-	25	050
ECXXT	Professional Elective-3	Theory	2	15	20	40	075
ECXXP	Professional Elective-3 Lab	Practical	1	25	-	25	050
EC50	Industry Interaction	Theory+ Practical	1	As Per Course (Optional, for those Opting for Honours/Minor Degree Programme)-During Winter Break of Sem 5 & Sem 6			050

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

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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Professional Elective - 2 Courses (ECXX)

Course Code	Course Name	Specialization Track Name#
EC25T	Soft Computing	Artificial Intelligence & Machine Learning
EC25P	Soft Computing Lab	
EC25T	Data Warehousing and Mining	Data Analytics
EC25P	Data Warehousing and Mining Lab	
EC26T	Principles of IOT	Internet of Things
EC26P	Principles of IOT Lab	
EC27T	Advanced VLSI Design	VLSI
EC27P	Advanced VLSI Design Lab	

#For details of Specialization Certificate, refer Appendix-A

Professional Elective - 3 Courses (ECXX)

Course Code	Course Name	Specialization Track Name#
EC28T	Machine Learning	Artificial Intelligence & Machine Learning
EC28P	Machine Learning Lab	
EC29T	Probabilistic Graphical Models	Data Analytics
EC29P	Probabilistic Graphical Models Lab	
EC30T	Embedded System Design with tiny OS	Internet of Things
EC30P	Embedded System Design with tiny OS Lab	
EC31T	Analog IC Design	VLSI
EC31P	Analog IC Design Lab	

#For details of Specialization Certificate, refer Appendix-A

Third Year B. Tech. Electronics and Computer Science - Summer Break

Course			Credits	Assessment Guidelines (Marks)	Total marks (Passing@40% of total marks)
Code	Head of Learning	Name			
EC46	Practical	Industry Internship	5	As per Internal and External guide	

Detailed Syllabus of Third Year Semester - V

Course Name: Presentation Skills

Course Code: HS04

Category: Humanities and Social Sciences

Preamble:

The course, Presentation Skills, is intended to equip students with the necessary skill set to help them bridge the gap from the campus to the corporate world. It will help them to be industry ready in sync with the requirements of the program they are pursuing.

Pre-requisites:

Nil

Course Objectives:

- To help students to bridge the gap between the campus and the corporate world.
- To help students to be industry ready by equipping them with the necessary soft skill set.

Course Outcomes:

Student will be able to:
CO 1: Deliver Corporate Presentations, Storyboards, and Business Plan.
CO 2: Participate in campus placements.
CO3: Build a personal brand and establish their presence as a global citizen.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	50	-	-	50

ISA:
25 Marks = 10 Marks for assignments + 15 Marks for Presentations

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Personal Branding	Introduction to Personal Branding –Purpose, Significance, Benefits and Techniques to build a personal brand Corporate/Organizational Branding Online identity of Brand on social media Maintenance and Improvement of your Brand Factors affecting your Brand	5
2	Corporate Presentations	Business Presentation Tips Digital Presentations PAIBOC Model and Minto Pyramid Principles	5
3	Business Plan Presentations	Introduction to Business Plans Company Overview & Industry Analysis Persuasive Communication in Marketing Strategy Operations Strategy in Financial Management Implementation Plan	5
4	Storyboarding and Storytelling	Visual Story Telling Video Presentations Story Structure with images Film and Animation	5
5	Placement Readiness	Mock HR Interviews Mock GDs Aptitude Tests Placement ready resume	5
6	Global Communication	An introduction to inter-cultural communication Introduction to languages and cultures Global media in mass communication Tips to become a global citizen Respecting cultural diversity	5
Total			**30**

Suggested List of Practicals:

1. Personal Branding
2. Personal Branding
3. Corporate Presentations
4. Corporate Presentations
5. Business Plan Presentations
6. Business Plan Presentations
7. Storyboarding and Storytelling
8. Storyboarding and Storytelling

9. Placement Readiness
10. Placement Readiness
11. Global Communication
12. Global Communication

Suggested List of Assignments:

1. Personal Branding (Individual)
2. Corporate Presentations (Group)
3. Business Plan Presentations (Group)
4. Storyboarding and Storytelling (Group)
5. Global Communication (Individual)

Suggested Online Courses:

1. Introduction to Personal Branding - https://www.coursera.org/learn/personal-branding
2. Strategic Self-Marketing and Personal Branding - https://www.coursera.org/learn/self-marketing
3. Learn to Storyboard for Film or Animation - https://www.udemy.com/course/storyboard-for-film-or-animation/
4. Powerful Tools for Teaching and Learning: Digital Storytelling - https://www.coursera.org/learn/digital-storytelling
5. Presentation Skills: Speechwriting, Slides and Delivery Specialization - https://www.coursera.org/specializations/presentation-skills
6. Business English for Cross-Cultural Communication - https://www.coursera.org/learn/cross-cultural-communication-business

Reference Books:

1. Murphy, "Effective Business Communication", Tata McGraw Hill.
2. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning.
3. Robbins Stephens, "Organizational Behaviour,", Education.
4. Kitty O Locker, "Business Communication- Building Critical Skills", McGraw Hill.

Course Name: Engineering Mathematics-V

Course Code: BS12

Category: Basic Sciences

Preamble:

This course introduces students to various optimization techniques & discrete structures concepts that are helpful for understanding many fundamental topics in Electronics & computer science fields.
Students will learn how to maximize or minimize both the linear programming problems and Non-linear programming problems by using different optimization techniques.
The course is designed for students with a solid understanding of mathematical programming, discrete structures, and error detection functions. By the end of the course, students will have a deep understanding of optimization techniques to optimize objective's function and will be equipped with the various advanced mathematical tools and techniques which are necessary to solve wide range of computational problems.

Pre-requisites:

Engineering Mathematics-III & IV

Course Objectives:

- Understand the reduction of Quadratic form to a canonical form and compute its rank with interpretation of its significances.
- Understand the various optimization techniques to optimize Linear Programming Problems and significances.
- Understand the optimization techniques for Non-Linear Programming Problems.
- Apply various techniques of Operation research to solve transportation, game theory and assignment problems.
- Understand the algebraic structures with binary operation and cyclic group for solving coding and decoding techniques in computational problems.
- To understand the coding and decoding mathematical techniques for Error Detections and Corrections in data science, machine learning and other fields that require strong analytical and problem-solving abilities.

Course Outcomes:

Learner will be able to:
CO1: Apply the knowledge to transform Quadratic form to a canonical to find its rank, index, and signature.
CO2: Apply various optimization techniques to optimize Linear Programming Problems and their significances.
CO3: Apply the optimization techniques for Non-Linear Programming Problems with or without constraints.

CO4: Apply the techniques of Operation research to optimize the transportation, game theory and assignment problems.
CO5: Understand the knowledge of algebraic structures with binary operation and cyclic group for coding and decoding techniques in computational problems.
CO6: Apply the knowledge of coding and decoding techniques for Error detections and corrections in data science, machine learning and other fields that require strong analytical and problem-solving abilities.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Tutorial	Theory	Practical/Tutorial
2	1	2	1

Assessment Guidelines:

Head of Learning	**ISA (20)**		**MSE**	**ESE**	**Total**
	Tutorials	**Class presence & Participation**			
Theory	10	10	30	50	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 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	Linear Algebra: Advance theory of Matrix-Quadratic Forms	1.1 Quadratic forms over real field, Linear Transformation of Quadratic form. 1.2 Rank, Index and Signature of quadratic form, Value-class of a quadratic form. 1.3 Reduction of Quadratic form to a canonical form using congruent transformations. 1.4 Reduction of Quadratic form to a canonical form using Orthogonal transformations **Self-learning Topics:** Singular Value Decomposition method (SVD), Similarity of matrices, Diagonalizable and Non-diagonalizable matrices. Application of Matrix Theory in machine learning and Google page rank algorithms, functions of matrix,	7
2	Linear programming problems (LPP)	2.1 Standard form of LLP 2.2 Simplex method to optimize objective function. 2.3 Artificial variables, Big-M method (Method of penalty). 2.4 Duality form and Dual of LPP	8

		2.5 Dual Simplex Method to optimize objective function. **Self-learning Topics:** linear programming problems from mathematical form into Optimization Toolbox solver syntax using the problem-based approach through MATLAB.	
3	Non-Linear programming problems (NLPP)	3.1 NLPP without constraints using Hessian Matrix. 3.2 NLPP with one equality constraint (two or three variables) using Lagrange's multipliers method. 3.3 NLPP with two equality constraints with Lagrange's multipliers method. 3.4 NLPP with one & two inequality constraint using Karush Kuhn-Tucker (KKT) conditions. **Self-learning Topics:** One-dimensional search method (Golden Search method, Newton's method). Gradient Search method and using NLPP's the problem-based approach through MATLAB.	7
4	Operations Research (OR)	4.1 Transportation problems: 4.1.1. North-West corner methos 4.1.2. Least cost method 4.1.3. Vogel's Approximation Method or Unit cost penalty method 4.2 Game Theory: Zero sum problems only. 4.3 Assignment problems **Self-learning Topics:** Network models, Inventory models, mixed strategy Nash Equilibrium, Cooperative and Non-cooperative game theory.	7
5	Linear Algebra: Algebraic structures	5.1 Algebraic structures with one binary operation 5.2 Groupoid- Closure Axiom property, 5.3 Semigroup- Groupoid with Associative Property 5.4 Monoid- Semigroup with identity element property 5.5 Group- Monoid with Inverse Element Property 5.6 Abelian Group- Commutative Group 5.7 Cyclic groups- Group with Generator Element 5.8 Order and subgroups. **Self-learning Topics:** Group Homomorphism, Isomorphism and Automorphism for coding theory.	8
6	Coding and Decoding theory	6.1 Definition of encoding function, weight, Hamming Distance, Error Detection and Correction. 6.2 Group codes with Composition Tables. 6.3 Minimum distance, Boolean matrix. 6.4 Parity Check Matrix to Encoding Function Generation 6.5 Maximum Like hood Decoding Technique to Decode given code using Encoding Function. **Self-learning Topics: S**tandard coding schemes such as block and convolutional codes, coding schemes such as	8

		Turbo and LDPC codes, and space time codes applied in digital communication systems as well as storage media.	
Total			**45**

Textbooks:

1. Schaum's Outline of Beginning Linear Algebra, by Seymour Lipschutz, McGraw-Hill New York, 2019.
2. Operations Research: An Introduction by Hamdy Taha, Pearson Education Inc.
3. Operations Research – Theory and Application by J. K. Sharma , Macmillan Publishers India.
4. Discrete Mathematics and its Applications, by Keenath H, Rosen, Tata Mcgraw Hill, 8th Edition 2018.
5. Operations Research – Problems & Solutions, by V.K. Kapoor, P K Gupta & Kanti Swarup, Sultan Chand & Sons, Publication, New Delhi.

Reference Books:

1. Discrete Mathematics with Coding Theory by Hugo D Junghenn by Taylor & Francis, CRS Press.
2. A first course in coding theory, by R. Hill, Oxford University Press, New York,
3. A Mathematical Theory of Communication, by C E Shennon.
4. Operations Research: Theory, Methods and Application by S.D. Sharma, Kedar Nath Ram Nath, Publication 2016.

Course Name: Basic VLSI Design

Course Code: EC10T

Category: Core.

Preamble:

Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

Course Objectives:

- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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.	Unit No.	Contents	Hrs.
1		**MOS Physics and MOSFET Scaling**	05
	1.1	MOS structure and MOS Capacitance, Region of Operation of MOS (Accumulation, Depletion, and Inversion), Threshold Voltage, Effect of Body Bias	
	1.2	Region of operation of MOSFETS, Drain Current Equation of MOSFET, Parasitic capacitances in MOSFET	
	1.3	MOSFET Scaling: Constant Voltage and Constant Field, Effect of Scaling on Device parameters. Short Channel Effect: Channel Length Modulation, sub-threshold conduction, hot electron effect and velocity saturation.	
2		**MOSFET Inverters**	07
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison.	
	2.2	Static & Dynamic Analysis of Ressitive load and CMOS Inverter: Calculation of critical voltages, noise margins, rise time, fall time, propagation delay and power dissipation. Design of CMOS inverter.	
3		**Combinational and Sequential Circuit Realization**	07
	3.1	Static CMOS, Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching	
	3.2	Basic gates and MUX realization using pass transistor and transmission gate logic Pseudo NMOS design styles, C^2MOS, Dynamic, Domino, NORA and Zipper CMOS design styles.	
	3.3	SR Latch, JK FF, D FF, 1 Bit Shift Register realization using CMOS logic	
4		**Semiconductor Memories**	06
	4.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier	
	4.2	DRAM: 1T & 3T DRAM, operation modes, leakage currents, refresh operation, physical design.	
	4.3	ROM Array: NAND and NOR based ROM array	
	4.4	Non-volatile read/write memories: Programming techniques for flash memory, Introduction to advances in non-volatile memories: MRAM, ReRAM	
5		**Data Path Design**	05
	5.1	Adder: Ripple Carry Adder, Carry Look Ahead (CLA) adder, Carry Generation circuit using MODL, Manchester carry chain. High-speed adders: carry skip, carry select, and carry save	
	5.2	Multipliers and shifter: Array multiplier and barrel shifter	
Total			**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
2	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5

Reference Books:

Sr. No	Text Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
2	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5
3	Logical Effort: Designing Fast CMOS Circuits	Ivan Sutherland and Bob Sproull,	The Morgan Kaufmann Series in Computer Architecture and Design	4th	2
4	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
5	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
7	Advanced Semiconductor Memories: Architectures, Designs, and Applications	Ashok K. Sharma,	Wiley Publication	4th	4
8	Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond	Denny D.Tang, Chi-Feng Pai,	Wiley online Library	2nd	4
9	Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications.	Daniele Ielmini, Rainer Waser,	Wiley online Library	3rd	4

Course Name: Basic VLSI Design Lab

Course Code: EC10P

Category: Core.

Preamble:
Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

Course Objectives:
- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

Course Outcomes:
After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

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

Suggested list of Practicals:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	To observe the effect of scaling on the characteristics of various MOSFET's	See the effect of Constant voltage and constant field Scaling	CO1
2	2	Design and Simulation to Symmetric and Non-Symmetric CMOS Inverter	How to control the inverter threshold	CO2
3	2	Comparison of different inverters based on Critical Parameter, timing parameters and Noise margins	Comparison of various types of inverters	CO2
4	2	Design and Implementation of Equivalent inverter for any CMOS logic function.	Concept of Equivalent inverter and relevance to timing analysis	CO2
5	3	Comparison of Pseudo NMOS and CMOS Logic functions.	Pseudo NMOS Logics	CO3
6	3	Comparison of dynamic and CMOS logic functions	Dynamic Logics	CO3
7	3	Comparison of domino and CMOS logic functions	Implementation of Uncomplemented functions	CO3
8	3	Implementation of functions using NORA and Zipper CMOS	Zipper CMOS	CO3
9	3	Implementation of Logic functions using NMOS, PMOS and Pass transistor logic	Change in voltage levels while passing a logic value	CO3
10	3	Implementation of 8:1 Mux and 1:8 Demux using NMOS, PMOS and transmission gates.	MUX and DEMUX operation using Pass transistor logic	CO3
11	4	Implementation of SRAM Cell	Read, Write and Hold operations in a DRAM	CO5
12	4	Design of NOR based and NAND Based ROM	Concept of Non-Volatile Memory	CO4
13	5	Implementation of 4-bit adder Ripple Carry Adder	Delay introduced while adding many bits	CO5
14	5	Implementation of 4- bit Carry look ahead adder with carry generation circuit using MODL	Reduction of delay during adding two binary numbers	CO5
15	5	Design of 4 x 4 Barel shifter using NMOS transistors	Data Steering, rotate left and rotate right operations	CO5
16	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5
17	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5

Course Name: Microcontroller and Applications

Course Code: EC11T

Category: Core.

Preamble:

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

Pre-requisite:

Digital Electronics
Computer Organization and Architecture
Fundamental concepts of processing

Course Objectives:

- To introduce the learner to the basic difference between Microprocessor and Microcontroller and design Microcontroller based systems
- To introduce the learner to the concept of assembly language programing
- To introduce the learner to the concept of embedded C programing

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Understand fundamental concepts of microcontrollers
CO2: Explain different building blocks of microcontrollers
CO3: Apply the knowledge of instruction set of microcontroller to develop assembly language and embedded C programs
CO4: Analyze the performance of a microcontroller by interfacing different peripherals and writing simple applications

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised 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	8051 Microcontroller Architecture	Introduction to the concepts of Microprocessors and Microcontrollers Overview of various available Microcontrollers Applications of Microcontrollers 8051 Architecture	4
2	8051 Internal Hardware	Memory organization Timers/Counters and programming Serial port and programming Interrupts and Interrupt control Power Saving modes	6
3	8051 Assembly language programming	Addressing modes of 8051 Instruction Set: Data transfer instructions, Arithmetic instructions, Logical instructions, Bit Processing, Branching instructions, Assembler directives	6
4	8051 programming in Embedded C	Embedded C-programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines Embedded C programming for 8051 (Timers/Counters, Serial port and Interrupts)	6
5	8051 Interfacing –Part 1	Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display Keyboard interfacing: 4x4 matrix keyboard	4
6	8051 Interfacing –Part 2	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35) Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor	4
Total			**30**

Text Books:

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

Course Name: Microcontroller and Applications Lab

Course Code: EC11P

Category: Core.

Preamble:

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

Pre-requisite:

Computer Organization and Architecture
Fundamentals of C programming

Course Objectives:

- To introduce learners with basic principles about microcontroller architecture, machine language, and low-level programming.
- To introduce learners with enough assembly language and embedded C to enhance their knowledge of today's most widely used microcomputer family.
- To Improving learners systems programming skills through programming exercises carried out by students.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Understand instruction set/format of a microcontroller.
CO2: Understand concept of assembly language and embedded C programming.
CO3: Develop assembly language and embedded C program for simple applications.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

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

Suggested List of Experiments

Sr No.	Suggested Experiments
1.	Develop assembly language code to add, subtract, multiply, divide, two, 8-bit numbers which will occupy minimum program memory space.
2.	Develop assembly language code to convert the input from keyboard to the format which can be used for processing internally.
3.	Given a bucket of ten, 8-bit numbers, develop assembly language code to find out smallest and largest element out of the bucket.
4.	Given an 8-bit numbers, develop assembly language code to check whether it is odd or even and to find out whether it has odd or even parity.
5.	It is required to glow the LED connected on P1.0 for some time and switch it OFF for the same time and repeat this for infinite time, develop the assembly code for the same.
6.	Develop assembly and C language code to display rolling pattern from left to right and right to left on the LEDs connected to PORT 1.
7.	Interface a 4 x 4 matrix type of keyboard with 8051. Develop assembly and C language code to detect the key closure.
8.	Interface a 4-phase stepper motor with 8051. Develop assembly and C language code to rotate the stepper motor clockwise for some time and anti-clockwise for the same time continuously.
9.	Interface a common cathode type of 7-segment display with 8051. Develop assembly and C language code to demonstrate Up/Down counting continuously.
10.	Interface 8-bit DAC, 0808 with 8051. Develop assembly and C language code to generate continuous rectangular wave with 1 kHz frequency and 40% duty cycle.

Text Books:

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

Course Name: Operating System

Course Code: EC12T

Category: Core

Preamble:

The goal of the course is to introduce the students to modern operating systems design. This course covers the design and implementation of operating systems with a focus on modern, concurrent kernels.

Pre-requisites:

Data Structure

Course Objectives:

- To enable learner to understand how operating system manages allocation and deallocation ofdifferent resources needed by user/ application.
- To enable learner to understand how operating system controls access to various resources andprovides security.
- To enable learner to evaluate performance of different approaches used by operating systems, foreffective resource utilization.

Course Outcomes:

Learner will be able to:
CO1: Understand the benefits of software modularity and how it applies to OS design.CO2: Compare various OS scheduling policies based on performance parameters.
CO3: Analyze methods to achieve synchronization and handle deadlocks.
CO4: Evaluate performance of Memory allocation and replacement policies.
CO5: Compare various files and I/O management techniques.
CO6: Understand how principles of general OS are applied in Linux OS.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table.

Notwithstanding the above, each course faculty shall have the choice to decide her/his assessmentmethodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of thesemester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction to Operating System	Operating System definitions, Functions of Operating System, Operating System Structures, User mode and kernel mode of a process, Types of Operating System, System Calls, Booting	4
2	Process Management and Synchronization	Process Management: Definition of Process, Process Control Block, Process Scheduling: Types and scheduling algorithms (FCFS, SJF, SRTN, Priority, RR), Threads: Definition and Concept of Multithreading. Process Synchronization: Principles of Concurrency, Inter-process communication, Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Producer and Consumer problem,	6
3	Deadlock	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	5
4	Memory Management	Memory Management Requirements, MemoryPartitioning: Fixed, Partitioning, Dynamic Partitioning,Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit,Paging and Segmentation, TLB, Page table design Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU	6
5	File Systems and I/O Management	Files and File Systems, Directory Systems, File allocation methods: Contiguous allocation, Linked allocation, Indexed allocation, Kernel I/O subsystem, Communication and Data Transfer with I/O Devices, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK, RAID Structure	5
6	The Linux System	Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, File Systems	3
Total			**30**

Textbooks:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014,ISBN-10: 0133805913 • ISBN-13: 9780133805918
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley&Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0

3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

Reference Books:

1. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

Course Name: Operating System Lab

Course Code:

EC12P

Category: Core

Preamble:

The course introduces learners to Linux shell commands and simulate various algorithms used by generalOS for managing resources. This courses project will explore the key operating system facilities in the relative isolation of an OS development framework with the goal of maximizing experiential learning.

Pre-requisites:

Data Structure Lab

Course Objectives:

- To enable learner to visualize the working of operating system by simulating techniques used by itto manage resources.
- To enable learner to apply techniques of process synchronization in multithreaded programs and hence develop concurrent applications.

Course Outcomes:

Learner will be able to:
CO1: Understand various shell commands of Linux OS.
CO2: Compare performance of different process scheduling policies.
CO3: Perform process/ thread synchronization for consistency and concurrency.
CO4: Simulate OS techniques for memory and virtual memory management.
CO5: Develop project to explore key OS facilities.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

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

Suggested List of Practicals:

Sr No.	Suggested Topic(s)
1.	Linux commands
2.	Non-Preemptive process Scheduling
3.	Preemptive process Scheduling
4.	Process synchronization using mutex locks.
5.	Deadlock Handling
6.	Dynamic memory allocation techniques
7.	Adddress translation in virtual memory
8.	Page replacement policies
9.	Disk scheduling techniques

Textbooks:

2. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014,ISBN-10: 0133805913 • ISBN-13: 9780133805918
3. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
4. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

Reference Books:

2. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

Course Name: Analysis of Algorithms

Course Code: EC13T

Category: Core

Preamble:

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

Pre-requisites:

Engineering Mathematics-III – Sem 3
Data Structures – Sem 3

Course Objectives:

- To provide a deep understanding of algorithmic design and analysis techniques that enable the development of efficient and effective algorithms for solving computational problems.
- To develop a strong foundation in the theory of algorithms, including concepts such as time and space complexity, algorithmic paradigms, data structures, graph algorithms, sorting and searching, and dynamic programming.
- To equip students with the tools and techniques necessary to compare and evaluate the performance of different algorithms and choose the best algorithm for a given problem.

To provide students with the knowledge and skills required for a successful career in software development, data analysis, and other fields that require strong analytical and problem-solving abilities

Course Outcomes:

Learner will be able to:
CO1: Analyze the time and space complexity of algorithms.
CO2: Apply and Analyze Divide and Conquer strategy to solve given problems.
CO3: Apply and Analyze Greedy strategy to solve given problems.
CO3: Apply and Analyze Dynamic Programming strategy to solve given problems.
CO4: Apply and Analyze Backtracking, Branch and Bound strategy to find solution for the given problems.
CO5: Classify a problem as computationally tractable or intractable and discuss strategies to address intractability.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

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 Algorithm Analysis	Performance analysis: Space, and Time complexity, Growth of function. Asymptotic Notations: Big-Oh, Omega Theta notation. Analysis of selection sort, insertion sort and Naïve String- Matching Algorithm. Recurrences: The substitution method, Recursion tree method, Master method.	8
2	Divide and Conquer Approach	General method, Analysis of Merge sort and Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	4
3	Greedy Method Approach	General Method, Analysis of Minimum cost spanning trees: Kruskal and Prim's algorithm, Single source shortest path: Analysis of Dijkstra's Algorithm, Fractional Knapsack Problem and Job Sequencing with Deadlines	6
4	Dynamic Programming Approach	General Method, Finding nth term in Fibonacci series, Single Source Shortest Path: Bellman Ford Algorithm All Pair Shortest Path: Floyd Warshall's Algorithm, Longest Common Subsequence,0/1 Knapsack Problem, Matrix Chain Multiplication and Sum of Subset Problem.	7
5	Backtracking and Branch and Bound	General Method, Backtracking: N-queen problem, Graph Coloring. Branch and Bound: 15 Puzzle problem, Travelling Salesperson Problem	3
6	Introduction to Complexity Theory	The class P and NP. Polynomial reduction. NP-Complete Problems. NP-Hard Problems	2
Total			**30**

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

Course Name: Analysis of Algorithms Lab

Course Code: EC13P

Category: Core

Preamble:

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

Pre-requisites:

Engineering Mathematics-III
Data Structures Lab

Course Objectives:

- To introduce the methods of designing and analyzing algorithms.
- Design and implement efficient algorithms for a specified application.
- Strengthen the ability to identify and apply suitable algorithms for the given real-world problem.
- Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

Course Outcomes:

At the end of the course, the students will be able to
CO1: Implement the algorithms using different approaches.
CO2: Analyze the complexities of various algorithms.
CO3: Apply and Analyze Greedy strategy to solve given problems.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	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.

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
1.	Introduction: Selection sort, Insertion sort
2.	Divide and Conquer Approach: Finding Minimum and Maximum, Merge sort, Quick sort, Binary search
3.	Greedy Method Approach: Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm
4.	Dynamic Programming Approach: Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Longest common subsequence
5.	Backtracking: N-queen problem Graph coloring

Text Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

Course Name: Mini Project-I

Course Code: EC45

Category: Project and Internship

Preamble:

Students will be acquainted with the process of identifying the needs and converting it into the problem. Third year students will be familiarized with the process of solving the problem in a group and applying basic engineering fundamentals to attempt solutions to the problems. This will inculcate the process of self-learning and research.

Pre-requisites:

All subjects they learned till TE and beyond.

Course Objectives:

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

Course Outcomes:

Learner will be able to:

CO1: Identify problems based on societal /research needs and apply Knowledge and skill to solve societal problems in a group.
CO2: Develop interpersonal skills to work as member of a group or leader and Excel in written and oral communication.
CO3: Draw the proper inferences from available results through theoretical/ experimental/simulations and analyze the impact of solutions in societal and environmental context for sustainable development
CO4: Use standard norms of engineering practices
CO5: Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
CO6: Demonstrate project management principles during project work.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	4	-	2

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	50	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Guidelines for Mini Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. 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.

Internal Assessment:

- The review/ progress monitoring committee shall be constituted by head of department. The progress of mini project to be evaluated on continuous basis, minimum two reviews during the semester.

1. Review 1: First review shall be for finalization of problem and proposed solution
2. Review 2: Second review shall be for implementation and testing of solution.

- 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 internal assessment marks for minor project shall be as below:

1. Marks awarded by guide/supervisor based on log book: 10
2. Marks awarded by review committee: 10
3. Quality of Project report: 05

Minor 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 and Societal impact
6. Full functioning of working model as per stated requirements
7. Effective use of skill sets
8. Effective use of standard engineering norms
9. Contribution of an individual's as member or leader
10. Clarity in written and oral communication In case of minor project-I all criteria in generic may be considered for evaluation of performance of students in mini project.

End semester examination assessment:

- Report should be prepared as per the guidelines issued by the department.
- Minor 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.

Detailed Syllabus of Third Year Semester - VI

Course Name: Digital Image Processing

Course Code: EC14T

Category: Core

Preamble:

Digital Image Processing introduces the fundamental concepts and general principles of image processing. It covers the key stages of digital image processing techniques. Students will also get an opportunity to implement the algorithms that are specific to real time image processing systems/applications.

Pre-requisites:

EC06-Signals & System

Course Objectives:

- Develop a solid foundation in the theoretical principles underlying digital image formation, representation, and enhancement.
- Gain proficiency in utilizing various image processing tools and algorithms to manipulate, analyze, and interpret digital images effectively.
- Learn to apply mathematical and computational techniques for filtering, segmentation, and feature extraction in digital image processing tasks.
- Explore advanced topics such as image restoration, image compression, and image recognition to address real-world challenges in diverse applications.

Course Outcomes:

Student will be able to:

CO1: Understand the fundamentals of Digital Image representation and simple pixel relations
CO2: Perform the basic image processing operation
CO3: Perform segmentation operation.
CO4: Perform Morphological operation
CO5: Understand different transform and enhancement in frequency domain
CO6: Apply compression and decompression techniques to different digital images

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	15	20	40	75

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Digital Image Processing Fundamentals:	Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System Elements of Visual Perception, A Simple Image Model, Two-dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels, Image File Formats: BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	4
2	Image Enhancement in Spatial Domain	Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter	6
3	Image Segmentation and Representation	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique. Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Two Dimensional Moments.	4
4	Binary Image Processing	Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or- Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling	4
5	Image Transforms and frequency domain processing:	Introduction to 2-Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform (FFT), Computation of 2 DFFT. Discrete Hadamard Transform (DHT), Fast Hadamard Transform (FHT), Discrete Cosine Transform (DCT), Introduction to Discrete Wavelet Transform (DWT)	6
6	Image Compression	Fundamentals: Coding Redundancy, Interpixel Redundancy, Psycho visual, Redundancy, Image Compression Models: The Source Encoder and Decoder, Lossless, Compression Techniques: Run Length Coding, Arithmetic Coding, Huffman, Coding, Differential PCM, Lossy Compression Techniques: Predictive Coding,	6

		Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1., Fidelity Criteria.	
Total			**30**

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 2nd edition, PHI/Pearson Education, 2002.
2. A.K.Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988.
3. Madhuri. A. Joshi, "Digital Image Processing-an algorithmic approach", 1st edition, PHI, 2006.

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, andMachine Vision", Second Edition, Thomson Learning, 2001.
3. Zeuch, Nello, "Understanding and Applying Machine Vision", CRC Press; 2nd edition.
4. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

Course Name: Digital Image Processing

Course Code: EC14P

Category: Core

Preamble:

Digital Image Processing introduces the fundamental concepts and general principles of image processing. It covers the key stages of digital image processing techniques. Students will also get an opportunity to implement algorithms that are specific to real time image processing systems/applications.

Pre-requisites:

Signals & System

Course Objectives:

- Gain proficiency in using industry-standard software tools and programming languages for digital image processing, such as MATLAB, Python with libraries like OpenCV or scikit-image, or other relevant software.
- Learn to implement and experiment with various image processing algorithms and techniques, including but not limited to filtering, edge detection, image enhancement, and morphological operations.
- Develop skills in image analysis, interpretation, and visualization through practical exercises and projects involving real-world image datasets.
- Explore the impact of parameter selection, algorithm choice, and preprocessing techniques on the outcomes of digital image processing tasks.

Course Outcomes:

Upon successful completion of the Digital Image Processing Lab, students will be able to:
CO1: Implement fundamental image processing algorithms: Apply various image processing techniques, including filtering, edge detection, and morphological operations, using appropriate programming languages and software tools.
CO2: Analyze and interpret digital images: Develop the ability to analyze and interpret digital images, identifying features and patterns relevant to specific applications.
CO3: Evaluate the performance of image processing algorithms: Assess the effectiveness of different image processing algorithms by comparing their results and considering factors such as computational efficiency and accuracy.
CO4: Solve image processing problems: Apply critical thinking and problem-solving skills to address image processing challenges encountered in lab exercises and projects.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	50

Suggested List of Practicals:

Sr No.	Suggested Experiment List
1.	Digital image conversion from RGB to gray, gray to binary
2.	Improve the quality of the 24-bit image by using Contrast stretching, Brightness, Log transformation
3.	Image enhancement using Histogram Equalization
4.	Sharpening and smoothing filters
5.	Fourier transforms on images
6.	Comparison of edge detection techniques
7.	Image compression using Bit plane slicing
8.	Image compression using DCT
9.	Morphological operations
10.	Segmentation using Background subtraction technique
11.	To analyze spatial and intensity resolution of images using MATLAB.

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 2nd edition, PHI/Pearson Education, 2002.
2. A.K.Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988.
3. Madhuri. A. Joshi, "Digital Image Processing-an algorithmic approach", 1st edition, PHI, 2006.

Reference Books:

1. S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, andMachine Vision", Second Edition, Thomson Learning, 2001.
3. Zeuch, Nello, "Understanding and Applying Machine Vision", CRC Press; 2nd edition.
4. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

Course Name: Theory of Computer Science

Course Code: EC15T

Category: Core

Preamble:
This course introduces students to formal language and automata theory. It covers different types of grammars and automata of different powers that are required to recognize languages defined by the grammars.

Pre-requisites:

BS05 (Engineering Mathematics 3)

Course Objectives:
• Acquire conceptual understanding of fundamentals of grammars and languages.
• Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
• Develop understanding of different types of Turing machines and applications.

Course Outcomes:
Learner will be able to:
CO1: Express rules in mathematical form (grammar).
CO2: Classify the problem into appropriate type of grammar.
CO3: Apply equivalence theory to recognize power of different automata.
CO4: Design Automata to meet the required specifications.
CO5: Create a tool that designs automata for a given grammar.

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/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Automata Theory	Basic Mathematical Fundamentals: Set Theory, Logic, Relations and Functions.	4
2	Introduction to Language & Finite Automata	Concepts: Symbol, Alphabet, Language and Grammar. Types of Grammar and Automata. Deterministic: 5-tuple representation of DFA. Designing DFA for Regular Language. Minimization of DFA. Non-Deterministic: 5-tuple representation of NFA with epsilon moves and NFA without epsilon moves. Equivalence of language recognized by NFA and DFA.	6
3	Regular Language and Grammar	Regular Expression and Regular Grammar. Equivalence of FA and Regular Expression. Properties of Regular Sets/ Languages. Classifying language as Regular and Non-regular.	4
4	Context Free and Sensitive Languages	Concepts: CFG, CFL, Derivations and Ambiguity. CFL as a superset of Regular. Normal Forms (CNF and GNF). Properties of CFL.	6
5	Push-Down Automata	7-tuple Deterministic PDA. Deterministic and NonDeterministic PDA. Equivalence of NPDA and CFL.	4
6	Turing Machine	Basic 7-tuple Turing Machine (TM). TM as acceptor & generator. Recursive and RE Languages. Decidability & Undecidability.	6
Total			**30**

Suggestion for list of Tutorials:

1. At-least one tutorial on each module. Recommended to add additional tutorials for module 3, 5 and 7.
2. Questions should be short and conceptual only. Each tutorial should be designed worth 2 Marks. Required to be solvable in 5 to 10 mins.
3. Tutorial to have major questions mapping to level 1 of Blooms Taxonomy (Understanding) and few questions mapping to level 2 of Blooms Taxonomy (Applying).

Text Books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman. Introduction to Automata Theory, Languages and Computation. Pearson Education. 2008.
2. Michael Sipser. Introduction to the Theory of Computation. Thomson Course Technology. 2012.
3. Peter Linz. An Introduction to Formal Languages and Automata. Jones and Bartlett Student Edition. 2016.

Course Name: Computer Network

Course Code:

EC16T

Category: Core

Preamble:

This course aims to give students an overview of the concepts and fundamentals of computer networks. It covers protocol layering, enabling students to analyze network performance. Additionally, the course provides insights into the functions of the OSI and TCP/IP models and various routing protocols.

Pre-requisites:

Digital Circuit Design
Digital Electronics
Electronic Devices and circuits

Course Objectives:

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand various transport layer and application layer protocols.

Course Outcomes:

Students will be able to:

1. Demonstrate the concepts of data communication and compare ISO - OSI model with TCP/IP model.
2. Explore different design issues at data link layer.
3. Design the network using IP addressing and subnetting / super netting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer.

Course Scheme:

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

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Computer Networks	Introduction to computer network, network application, (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services. Revisiting OSI Model & TCP/IP Model.	4
2	Data Link Layer	Data Link Layer 2.1 DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC 2.2 Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3)	8
3	IP Addressing & Network Layer	IPv4 Addressing (classful and classless), Subnetting, Super netting design problems, IPv4 Protocol, Network Address Translation (NAT). IPv6 Addressing, Transition from IPV4 to IPV6	8
4	Routing Protocols	Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing	4
5	Transport Layer	Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers. TCP Flow control (sliding Window), TCP Congestion Control: Slow Start.	4
6	Application Layer	Protocols: DNS, HTTP, SMTP, Telnet, FTP, DHCP	2
Total			**30**

Textbooks:

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

Reference Books:

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.

Course Name: Computer Networks Lab

Course Code:

EC16P

Category: Core

Preamble:

This course is to provide students with an overview of the concepts and fundamentals of computer networks.

Pre-requisites:

Digital Circuit Design Lab
Digital Electronics Lab

Course Objectives:

1. To practically explore OSI layers and understand the usage of simulation tools.
2. To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3. To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols.

Course Outcomes:
Learner will be able to:
CO1: Execute and evaluate network administration commands and demonstrate their use in different network scenario
CO2: Demonstrate the installation and configuration of network simulator.
CO3: Demonstrate and measure different network scenarios and their performance behavior. CO4: Implement the socket programming for client server architecture.
CO5: Analyze the traffic flow of different protocols
CO6: Design a network for an organization using a network design tool

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

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

Suggested List of Practicals

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

Sr No	Suggested Topic(s)
1	Study, understand and perform various networking commands: Ping, Tracert, trace route, ipconfig, ifconfig, nslookup, netstat
2	Designing Network Layout
3	Program for Error Detection
4	Program for Error Correction
5	Program on IP Addressing
6	Case study on Subnetting and Super netting
7	Socket Programming
8	Chat Application
9	Installation and configuration of Wireshark tool Study the packet transmission using Wireshark and understand/visualize the IP protocol
10	Cisco Packet Tracer

Textbooks:

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

Reference Books:

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, “TCP/IP Protocol Suite”, Tata McGraw Hill edition, Third Edition.

Course Name: Analog & Digital Communications

Course Code: EC17T

Category: Core

Preamble:

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

Pre-requisites:

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

Course Objectives:

- To understand the fundamental concepts and methods employed in analog and digital communications.
- To learn different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore baseband and bandpass communication methods, as well as various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

Course Outcomes:

Learner will be able to:
CO1: Understand the fundamental principles and components of communication systems.
CO2: Apply knowledge of basic analog communication systems.
CO3: Evaluate the effects of noise on communication systems.
CO4: Interpret the principles governing digital communication systems.
CO5: Create and execute error control coding schemes to enhance communication reliability.
CO6: Investigate the practical applications of multi-user radio communication through case studies and applications.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

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 communication systems	• Basic elements of a communication system (source, transmitter, channel, receiver, destination) • Signal representation: time domain and frequency domain (Fourier Series & Fourier Transform) • Introduction to communication models	6
2	Analog communication systems	• Amplitude Modulation (AM): Double-sideband suppressed carrier (DSB-SC) modulation, Single-sideband (SSB) modulation and Vestigial sideband (VSB) modulation, AM receivers: envelope detector. • Angle Modulation (FM): Wideband FM (WBFM) and Narrowband FM (NBFM), FM receivers: discriminator.	6
3	Noise Analysis in communication systems	• Introduction to noise sources (thermal noise, shot noise) • Signal-to-Noise Ratio (SNR) and its importance. • Noise analysis in communication systems • Inter symbol inference, Inter channel interference	3

4	Digital communication systems	• Introduction to digital signals and baseband transmission • Sampling theorem and Nyquist rate • Quantization and pulse code modulation (PCM) • Line coding techniques: Unipolar, Bipolar, Polar,RZ, NRZ, Manchester, Differential Manchester • Digital modulation techniques: Binary Phase Shift Keying (BPSK), Binary Amplitude Shift Keying (BASK), Binary Frequency Shift Keying (BFSK) Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Phase Shift Keying (QAPSK)	8
5	Error control coding	• Error control coding: Channel Capacity, Linear Block Codes, Cyclic Codes – ARQ Techniques • Simulation of error control coding schemes.	4
6	Multi-user radio communication	• Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA) – Cellular • Concept and Frequency Reuse – Channel Assignment and Handover Techniques – Overview of Multiple Access Schemes – Satellite Communication, Optical Fiber Communication, Mobile communication	3
Total			**30**

Textbooks:

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

Reference Books:

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

Course Name: Analog & Digital Communications Lab

Course Code: EC17P

Category: Core

Preamble:

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

Pre-requisites:

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

Course Objectives:

- To simulate different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

Course Outcomes:

Learner will be able to:
CO1: Apply knowledge of basic analog communication systems.
CO2: Simulate the principles governing digital communication systems.
CO3: Create and execute error control coding schemes to enhance communication reliability.
CO4: Investigate the practical applications of multi-user radio communication through case studies and applications.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	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.

Suggested List of Practical's:

Sr No.	Suggested Topic(s)
11.	Amplitude modulation - generation and detection
12.	Frequency modulation generation and detection
13.	Simulation of AM/ FM receiver
14.	Signal sampling and reconstruction
15.	PCM coding and decoding
16.	Line Coding
17.	Linear Block Codes
18.	BPSK Modulation & Demodulation
19.	BFSK Modulation & Demodulation
20.	BASK Modulation & Demodulation
21.	QPSK Modulation & Demodulation

Useful Tools and Laboratory: -

1. NPTEL MOOC Courses
2. Swayam Portal AICTE
3. National Digital Library, IIT KGP.
4. Virtual Lab by IIT Bombay.
5. MATLAB
6. SCILAB
7. LABVIEW
8. Various Analog and Digital Communication Trainers.

Text Books:

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

Reference Books:

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

Appendix-A

Guidelines for Professional Elective Courses and Specialization Certificate

Professional Elective courses are designed to meet industrial requirements. All learners must opt for 6 professional elective courses (both Theory and Practical component) as a part of the requirement for B.Tech. Degree.

Specialization Certificate is introduced in order to build competency of learners in the chosen domain. Department of Computer Engineering offers the following specialization tracks:

1. Artificial Intelligence and Machine Learning (AIML)
2. Data Analytics (DA)
3. Internet of Things (IoT)
4. VLSI Design (VLSID)

Learners can take courses from any track. **However, if learners complete all Professional Elective courses from the same chosen track, they will be eligible to receive a Specialization Certificate from the Institute.**

Learners who choose professional elective courses from different specialization tracks will not be eligible for a Specialization Certificate.

It should be noted that there are no additional credit requirements for these specializations.

AIML track: Courses to be chosen for specialization in Artificial Intelligence and Machine Learning

Semester	Course Code	Course Name
V	EC21T	Artificial Intelligence
V	EC21P	Artificial Intelligence Lab
VI	EC25T	Soft Computing
VI	EC25P	Soft Computing Lab
VI	EC29T	Machine Learning
VI	EC29P	Machine Learning Lab
VII	EC33T	Data Analytics & Visualization
VII	EC33P	Data Analytics & Visualization Lab
VII	EC37T	Deep Learning
VII	EC37P	Deep Learning Lab
VII	EC41T	Natural language processing
VII	EC41P	Natural language processing Lab

DA track: Courses to be chosen for specialization in Data Analytics

Semester	Course Code	Course Name
V	EC22T	Advanced Database Management
V	EC22P	Advanced Database Management Lab
VI	EC26T	Data Warehousing and Mining
VI	EC26P	Data Warehousing and Mining Lab
VI	EC30T	Probabilistic Graphical Models
VI	EC30P	Probabilistic Graphical Models Lab
VII	EC34T	Big Data Analytics
VII	EC34P	Big Data Analytics Lab
VII	EC38T	Recommendation Systems
VII	EC38P	Recommendation Systems Lab
VII	EC41T	Text, Web & Social Media Analytics
VII	EC41P	Text, Web & Social Media Analytic Lab

IoT track: Courses to be chosen for specialization in Internet of Things

Semester	Course Code	Course Name
V	EC23T	Modern Sensors for IOT
V	EC23P	Modern Sensors for IOT Lab
VI	EC27T	Principles of IOT
VI	EC27P	Principles of IOT Lab
VI	EC31T	Embedded System Design with tiny OS
VI	EC31P	Embedded System Design with tiny OS Lab
VII	EC35T	IoT and Edge Computing
VII	EC35P	IoT and Edge Computing Lab
VII	EC39T	IoT Security and Trust
VII	EC39P	IoT Security and Trust Lab
VII	EC42T	Industrial IOT
VII	EC42P	Industrial IOT Lab

VLSI track: Courses to be chosen for specialization in Very Large-Scale Integration

Semester	Course Code	Course Name
V	EC24	Digital System Design
V	EC24	Digital System Design Lab
VI	EC28	Advanced VLSI Design and Technology
VI	EC28	Advanced VLSI Design and Technology Lab
VI	EC32	Analog IC Design
VI	EC32	Analog IC Design Lab
VII	EC36	ASIC and Verification
VII	EC36	ASIC and Verification Lab
VII	EC40	System on Chip
VII	EC40	System on Chip Lab
VII	EC43	Mixed Signal VLSI
VII	EC43	Mixed Signal VLSI Lab

Detailed Syllabus of AIML Track – Sem V & VI

Course Name: Artificial Intelligence

Course Code: EC21T

Category: PEC (AIML)

Preamble:

Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes creating intelligent machines that work and react like humans.

Pre-requisites:

NIL

Course Objectives:

1. Understand Artificial Intelligence
2. Know and use various problem-solving methods
3. Acquire and use knowledge representation methods in AI
4. Understand and design Artificial intelligence Agents
5. Know and identify AI applications
6. Design and apply Artificial Intelligence in community

Course Outcomes:

Learner will be able to:

CO1: To understand the basics of Artificial Intelligence

CO2: To know and use various problem-solving methods

CO3: To acquire and use knowledge representation methods in AI

CO4: To understand and design Artificial intelligence Agent

CO5: To know and identify AI applications

CO6: To design and apply Artificial Intelligence in community

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Artificial Intelligence	• Artificial Intelligence Introduction, Intelligent systems • Categorization of Intelligent Systems • Characteristics of AI • Current Trends in AI	4
2	Intelligent Agents	• Agents and Environment, Structure of Agents, Types of agents, Learning agent, • Agent communication • Negotiation and Bargaining • Argumentation among Agents • Trust and Reputation in Multi-agent systems	5
3	Problem Solving Methods	• Uninformed search Breadth First Search, Depth First Search, Depth First iterative deepening, • Informed Search Greedy best first, A*, Heuristic search • Adversarial Search Game playing, alpha beta pruning, Min-Max search • Local search algorithms and optimization Hill climbing search, Genetic algorithms,	6
4	Knowledge Representation	• Knowledge Representation, brief overview of propositional logic, FOL syntax and semantic, forward chaining and backward chaining • Unification, resolution, • Uncertain knowledge and Engineering: knowledge in uncertain domain, semantics of belief network, simple inference in belief network	6
5	Planning and Learning	• Planning: Planning problem, Partial order planning, Hierarchical planning, Conditional planning • Learning: Forms of Learning, Theory of learning, PAC learning, Introduction to statistical learning	5
6	Artificial Intelligence Applications with Real Time USECASE	Students are supposed to study any AI Application and provide insights about the concepts used in respective application.	4
Total			**30**

Textbooks:

1. Artificial Intelligence: A Modern Approach (AIMA) is a university textbook on artificial intelligence, written by Stuart J. Russell and Peter Norvig.
2. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education

Reference Books:

1. David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press.
2. G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fourth Edition, Pearson Education.
3. J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers.

Course Name: Artificial Intelligence Lab

Course Code: EC21P

Category: PEC (AIML)

Preamble:

Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It emphasizes creating intelligent machines that work and react like humans. AI labs will help to understand these concepts with practical experiments.

Pre-requisites:

NIL

Course Objectives:

- Understand Artificial Intelligence
- Know and use various problem-solving methods
- Acquire and use knowledge representation methods in AI
- Understand and design Artificial intelligence Agents
- Know and identify AI applications
- Design and apply Artificial Intelligence in community

Course Outcomes:

Learner will be able to:

CO1: To understand and conceptualize basic ideas and techniques in artificial Intelligence

CO2: To know and use various problem-solving methods

CO3: To acquire and choose appropriate knowledge representation methods in AI

CO4: To understand and design Artificial intelligence Agents

CO5: To know and identify AI applications

CO6: To design and develop Artificial Intelligence Applications in real world scenarios

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

Suggested List of Practicals:

Sr No.	Title of Practicals
1	One case study on AI applications published in IEEE/ACM/ Springer Journals
2	Program on uninformed search methods (BFS)
3	Program on uninformed search methods (DFS)
4	Program on informed search methods (A *)
5	Program on game playing assignments (Minmax)
6	Program on First order logic
7	Project (Develop any small AI Application)

Course Name: Soft Computing

Course Code: EC30T

Category: PEC (AIML)

Preamble:

Soft computing is an emerging approach to computing based on some biological inspired methodologies such as genetics, evolution, ant's behaviors, particles swarming, human nervous systems, etc. Now, soft computing is the only solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

After completing this course, you will be able to learn:

- Fuzzy logic and its applications.
- Artificial neural networks and its applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learner will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugano models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

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 Soft Computing	Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	4
2	Fuzzy Set Theory	Fuzzy Sets, Fuzzy relations, Fuzzification and Defuzzification. Features of the membership Functions, Fuzzy Max-Min and Max-Product Composition	4
3	Fuzzy Rules, Reasoning and Inference System	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugano FIS, Comparison between, Mamdani and Sugano FIS	4
4	Genetic Algorithm	An Introduction to genetic Algorithms: Genetic Algorithms Mathematical Foundations, Schemata Revisited Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA, Generation of Graph Results of Handwriting Recognition, Effect of Genetic Algorithms, Distance Optimization, Style Optimization, Solving single-objective optimization problems using GA, Multi-objective Optimization Problem Solving	6
5	Neural Networks	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model Supervised Learning algorithms: Perceptron (Single Layer, Multi-layer), Linear separability, Delta learning rule, Back Propagation algorithm, Un-Supervised Learning algorithms: Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	8
6	Hybrid system	Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System (ANFIS)	4
Total			**30**

Textbooks:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education
3. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional

Course Name: Soft Computing Lab

Course Code: EC30P

Category: PEC (AIML)

Preamble:

Soft computing provides a reliable solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc

Pre-requisites:

- Engineering Mathematics (All Semesters)

Course Objectives:

After completing this course, you will be able to learn:

- Fuzzy logic and its applications.
- Artificial neural networks and their applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft computing to solve problems in varieties of application domains.

Course Outcomes:

Learner will be able to learn:
CO1: Explain the fundamentals of soft computing, its constituents, and its adaptability.
CO2: Apply fuzzy set theory and design membership functions for imprecise data.
CO3: Develop fuzzy inference systems using Mamdani and Sugeno models for decision-making.
CO4: Solve optimization problems using genetic algorithms and their operators.
CO5: Implement neural network algorithms for supervised and unsupervised learning tasks.
CO6: Design hybrid systems like ANFIS by integrating neural networks and fuzzy logic.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	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.

Suggested List of Practical's:

Sr No.	Suggested List of Experiments
1.	Study of Fuzzy set and Theory
2.	Implementing basic fuzzy Operations
3.	Implementation of fuzzy set close to N
4.	Study of the Fuzzy toolbox.
5.	Implementing Train Controller problem
6.	Implementing Washing machine problem
7.	Implementing Water purification problem
10.	Implementing Tipper problem
11.	Implementing the Perceptron learning rule.
12.	Implementing the Curve Fitting using Genetics algorithm.
13.	Development of an Adaptive Neuro-Fuzzy Inference System (ANFIS)
14.	Backpropagation Algorithm for Multilayer Perceptron

Text Books:

1. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Willey, 2nd
2. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press
3. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India
4. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey

Reference Books:

1. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
2. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education.
3. Fuzzy Logic: A Practical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional.

Course Name: Machine Learning

Course Code: EC25T

Category: PEC (AIML)

Preamble:
This course is designed to provide students with a comprehensive understanding of fundamental concepts, algorithms, and techniques in machine learning. Through a combination of theoretical lectures, hands-on lab sessions, and real-world projects, students will gain the necessary knowledge and skills to apply machine learning effectively in practical scenarios.

Pre-requisites:

- EC09 (Python Programming)

Course Objectives:

- To understand Machine Learning Concepts.
- To apply various data processing techniques.
- To understand and apply supervised and unsupervised algorithm concepts.
- To apply knowledge of machine learning to solve real-world problems.

Course Outcomes:

Students will be able to:
CO1: Understand the fundamental concepts and scope of Machine Learning.

CO2: Apply various techniques of Data Preprocessing to clean, transform, and prepare raw data.

CO3: Analyse and interpret the concepts and model representations of Linear Regression and Logistic Regression.

CO4: Compare decision trees, random forests, and ensemble methods for supervised learning.

CO5: Utilize clustering algorithms along with dimensionality reduction techniques to identify patterns and reduce the dimensionality of data.

Course Scheme:

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

Assessment Guidelines:

Head	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

Detailed Syllabus:

Module no	Module name	Content	No of Hours
1	Introduction to Machine Learning	Introduction to ML, Definition and scope of Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Applications of Machine Learning in various domains, Steps in Developing Machine Learning Applications	4
2	Data Preprocessing	Importance of Data Preprocessing, Identifying and Handling Missing Data, Feature Scaling – Standardization, Normalization, Robust Scaling, Encoding Categorical Data - Label Encoding, One-Hot Encoding etc.	6
3	Supervised Learning-1	Linear Regression- concepts and model representation, Logistic Regression- concepts and model representation, and Evaluation metrics for linear regression - Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), R-squared (R^2) Score.	6
4	Supervised Learning-2	Decision trees, random forests, and ensemble methods.	6
5	Unsupervised Learning	Clustering algorithms - K-means, Hierarchical, Dimensionality Reduction – Principal Component Analysis (PCA).	8
Total			**30**

Textbooks:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.
2. Hastie, Tibshirani, Friedman, "Introduction to Statistical Machine Learning with Applications in R", Springer, 2nd Edition, 2012
3. Peter Harrington, "Machine Learning in Action", DreamTech Press.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning"
2. C. M. Bishop, "Pattern Recognition and Machine Learning"

Course Name: Machine Learning Lab

Course Code: EC25P

Category: PEC (AIML)

Preamble:
This course is designed to provide students with a comprehensive understanding of fundamental concepts, algorithms, and techniques in machine learning. Through a combination of theoretical lectures, hands-on lab sessions, and real-world projects, students will gain the necessary knowledge and skills to apply machine learning effectively in practical scenarios.

Pre-requisites:

- EC09 (Python Programming)

Course Objectives:

- To understand Machine Learning Concepts.
- To apply various data processing techniques.
- To understand and apply supervised and unsupervised algorithm concepts.
- To apply knowledge of machine learning to solve real-world problems.

Course Outcomes:

CO1: Understand the fundamental concepts and scope of Machine Learning.

CO2: Apply various techniques of Data Preprocessing to clean, transform, and prepare raw data.

CO3: Analyse and interpret the concepts and model representations of Linear Regression and Logistic Regression.

CO4: Compare decision trees, random forests, and ensemble methods for supervised learning.

CO5: Utilize clustering algorithms along with dimensionality reduction techniques to identify patterns and reduce the dimensionality of data.

Course Scheme:

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

Assessment Scheme:

Head	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

Suggested List of Practical:

1. Setting up Python environment, introduction to libraries like NumPy, Pandas, and scikit-learn.
2. Hands-on data preprocessing using Python libraries.
3. Implementing regression and classification algorithms.
4. Implementing decision trees and ensemble methods.
5. Implementing clustering and dimensionality reduction techniques.
6. Hands-on projects covering real time applications of machine learning.

Textbooks:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.
2. Hastie, Tibshirani, Friedman, "Introduction to Statistical Machine Learning with Applications in R", Springer, 2nd Edition, 2012
3. Peter Harrington, "Machine Learning in Action", DreamTech Press.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition, 2013
2. C. M. Bishop, "Pattern Recognition and Machine Learning

Detailed Syllabus of DA Track – Sem V & VI

Course Name: Advanced Database Management System

Course Code: EC22T

Category: PEC (Data Analytics)

Preamble:

Mastering on mastering advanced database systems demands a structured approach. Our comprehensive roadmap covers query processing, advanced data management, distributed databases, big data, NoSQL, enhanced data models, and information retrieval. Each module delves into its domain, blending theory with hands-on tasks. This systematic curriculum ensures learners gain a holistic understanding of modern database systems, ready to navigate complex data landscapes.

Pre-requisites:
EC08 - DBMS

Objective:

1. To impart knowledge related to query processing and query optimization phases of a database management system.
2. To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.
3. To introduce advanced database models like distributed databases.
4. To create awareness of how enterprise can organize and analyse large amounts of data by creating a Data Warehouse.
5. To understand the process of data extraction, transformation and loading. 6 To understand the concept of Big data and NoSQL databases.
6. To learn different IR models and queries in IR Systems

Course Outcomes:
Learner will be able to:

CO1: Measure query costs and design alternate efficient paths for query execution.

CO2: Apply sophisticated access protocols to control access to the database.

CO3: Design distributed databases for improving resource utilization, availability and performance

CO4: To apply the traits of temporal and spatial data models as per the need

CO5: Perform efficient and effective retrieval of information to facilitate the decision making

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression Estimating Statistics of Expression Results Choice of Evaluation Plans. Self-learning Topics: Solve problems on query Optimization	6
2	Access Control Mechanism	Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role Based Access Control, Remote Database access protocol. Self-learning Topics: Learn Data Security concepts like Authentication, Authorization and encryption.	6
3	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. Self-learning Topics: Query Optimization in Distributed Databases	6
4	Enhanced Data Models	Active Database Concepts and Triggers, Temporal Database, Spatial Database, Introduction to Deductive Databases Self-learning Topics: Case Study like : "Temporal Dynamics in Information Retrieval: Modelling Temporal Relevance and Query Intent Shifts Over Time"	6
5	Introduction to Information Retrieval	Retrieval Models, Types of Queries in IR Systems, Text Preprocessing Self-learning Topics : Case Study like "Information retrieval evaluation in practice"	6
Total			**30**

Textbooks:

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

References:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling", 3rd Edition. Wiley India.
3. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 9th Edition

Course Name: Advanced Database Management System Lab

Course Code: EC22P

Category: PEC (Data Analytics)

Preamble:
The Advanced Database Laboratory immerses students in leading-edge database technologies and advanced concepts, expanding upon foundational knowledge from prerequisite courses. Through hands-on exploration, students delve into topics including NoSQL databases, distributed data management, query processing and optimization, and advanced SQL techniques. Practical exercises and projects facilitate a deeper understanding of database design, optimization, and administration. Additionally, students gain valuable insights into emerging trends and challenges within the dynamic realm of database management.

Pre-requisites:

EC08 - DBMS

Objective:

- Mastering Conceptual DB Design using EER Model and implementing it using SQL DDL
- Explore advanced SQL concepts
- Gain practical experience in working with distributed databases, temporal data bases, spatial data bases and active databases and proposing a solution using appropriate model(s).
- Learn how to integrate PHP scripts with MySQL databases to create dynamic web applications.
- Develop proficiency in designing, implementing, and optimizing complex database systems for real-world applications and interface a database with front end tools
- Apply best practices in database administration, security, and scalability to ensure robust and efficient database systems.

Course Outcomes:

Learner will be able to:

CO1: Students will be able to design database schemas using EER model techniques and implement them using SQL.

CO2: Students will demonstrate proficiency in writing advanced SQL queries and understand query optimization principles.

CO3: Students will develop skills in accessing and manipulating databases through JDBC in Java programs.

CO4: Students will understand query evaluation plans, indexing strategies, and their impact on database performance.

CO5: Students will implement distributed database solutions, including partitioning strategies, for scalability and performance.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

Suggested list of experiments:

Sr. No.	List of experiments
1	Design EER Model for a real-life scenario and implement it using SQL
2	Understand and compare performance by rewriting queries using indexing
3	Implement the Program to estimate cost of the query for various join operation
4	Build Web Applications with access control features
5	Explore the security and access control features of PostgreSQL (or equivalent system)
6	Implementation of fragmentation in distributed database environment.
7	Implementation of triggers for understanding features of active database
8	Design a temporal and spatial data base schema , map it to tables and solve queries involving temporal and spatial attributes

Textbooks:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision wesley, 2007
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011

Reference Books:

1. T. Özsu and P. Valduriez, Distributed Database Systems. Prentice Hall, Oct. 2011. [ISBN: 013616736X]
2. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Martin Fowler and Pramod J. Sadalage

Course Name: Data Warehousing & Mining

Course Code: EC26T

Category: PEC (Data Analytics)

Preamble:

In today's data-driven world, organizations rely heavily on data warehousing and data mining techniques to extract meaningful insights from large volumes of data. This course aims to provide learners with a comprehensive understanding of the foundational principles of data warehousing and basic concepts of data mining. Through theoretical exploration, participants will gain insights into the design, implementation, and administration of data warehouses, as well as the fundamental techniques and applications of data mining.

Pre-requisites:

EC22T - Advance Database Management Systems

Course Objectives:

- Understand the fundamental concepts and historical development of data warehousing.
- Gain insights into the design principles and architecture of data warehouses.
- Explore the processes involved in ETL (Extract, Transform, Load) in data warehousing.
- Understand the fundamental concepts and architecture of data lakes as centralized repositories for storing and processing diverse data types.
- Familiarize oneself with basic concepts and techniques of data mining, including preprocessing, model building, and evaluation.
- Explore the various methods and applications of data mining in real-world scenarios.

Course Outcomes:

On successful completion, of course, learner/student will be able to:

CO1: Demonstrate a comprehensive understanding of the fundamental concepts of data warehousing and its architecture.

CO2: Design a data warehouse schema using dimensional modeling techniques and explain the ETL process involved in data warehousing.

CO3: To introduce concepts and fundamentals of data lakes

CO4: Understand data mining principles and perform data preprocessing and Visualization.

CO5: Understand the concept of data mining and identify appropriate data mining algorithms to solve real-world problems.

CO6: Implement basic data mining algorithms such as classification, clustering, and association mining

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 data warehouse and ETL Process	Introduction to Data Warehouse and Data Mart , Data warehouse architecture, Data warehouse vs Data Marts Dimensional modeling, Design of information package, star schema, snowflake schema, fact constellation schema, factless fact tables, aggregate fact tables. OLAP operations ETL process: Basic steps of the ETL process, different extraction methods, transformations, and different loading techniques.	8
2	Introduction to Data Lakes	Definition, key attributes of data lake, challenges, functionalities, architecture, Curating data lakes, Data Lake vs. data warehouse	3
3	Data Exploration and Data Preprocessing	The KDD process, Data mining system architecture, Data Exploration: Types of Attributes, Statistical Description of Data,Data Visualization: box plots, line & bar charts, and scatter plots.Data Preprocessing: Descriptive data, summarization, Cleaning, Integration & transformation, Data reduction.	5
4	Classification	Introduction to data mining techniques, Classification: Decision Tree Induction, Naïve Bayesian Classification. Regression: Simple and multiple	5
5	Clustering	Clustering: Partition based: K-means, Hierarchical Methods (Agglomerative, Divisive).	4
6	Mining frequent patterns and associations	Basic Concepts: Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules; Frequent Itemset. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from requent Itemset, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical	5

		data formats.	
		Total	**30**

Textbooks:

3. Margy Ross and Ralph Kimball, "The Data Warehouse Toolkit", 3rd edition, Willey
4. Paulraj Ponniah, "Data Warehouse Fundamentals", Wiley-Interscience Publication
5. Bill Inmon, "Data Lake Architecture", 1st edition, Technics Publication
6. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", 3rd edition, Elsevier

Reference Books:

1. W. H. Inmon, "Building the Data Warehouse", 3rd edition, Wiley Computer Publishing

Course Name: Data Warehousing & Mining Lab

Course Code: EC26P

Category: PEC (Data Analytics)

Preamble:
In today's data-driven world, organizations rely heavily on data warehousing and data mining techniques to extract meaningful insights from large volumes of data. This course aims to provide learners with a comprehensive understanding of the foundational principles of data warehousing and basic concepts of data mining. Through hands-on exploration, learners will gain insights into the design and implementation of data warehouses, as well as the fundamental techniques and applications of data mining.

Pre-requisites:
EC22P – Advance Database Management Systems Lab

Course Objectives:

- Understand and design the concepts of star, snowflake, and galaxy schemas for efficient data organization in data warehouses.
- Understand and execute complex queries and apply OLAP operations effectively.
- Understand various preprocessing and visualization techniques.
- Apply regression techniques and classification algorithms to analyze data, predict outcomes, and gain valuable insights.
- Implement clustering algorithms to effectively group data based on similarities, facilitating improved data organization and analysis.
- Apply association rule mining techniques to identify and analyze patterns and relationships between variables in large datasets.

Course Outcomes:
Learner will be able to:
CO1: Develop and design star, snowflake, and galaxy schemas for data warehouses.
CO2: Execute complex queries and perform Online Analytical Processing (OLAP) operations to analyze data.
CO3: Apply various data preprocessing and visualization techniques to effectively communicate data insights and patterns.
CO4: Implement regression techniques and classification algorithms to analyze data, predict outcomes, and gain valuable insights in practical scenarios.
CO5: Implement clustering algorithms to group data based on similarities.
CO6**:** Implement association rule mining techniques to identify and analyze patterns and relationships

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of experiments:

Sr. No.	List of experiments	Concept
1	Design Information Package, Star Schema & Snowflake Schema	Data Warehouse schema design
2	DW queries & OLAP operations	OLAP
3	Apply different visualization techniques	Data Visualization
4	To implement linear regression (Simple & Multiple) -Python	Regression analysis
5	To implement the ID3 decision tree algorithm – rapid miner and Weka	Classification
6	To implement Naïve Bayes classifier(python)	Classification
8	To implement the K-means clustering algorithm – weka and Rapidminer	Clustering
9	To implement Agglomerative clustering algorithm -python	Clustering
10	To implement the Apriori algorithm – Weka and RapidMiner	Association Analysis

Course Name: Probabilistic Graphical Model

Course Code: EC29T

Category: PEC (Data Analytics)

Preamble:

Probabilistic graphical models (PGMs) are a powerful framework that combines probability theory and graph theory to represent and reason about uncertainties in complex systems. They use graphs to encode the conditional dependencies between random variables, facilitating efficient computation of joint distributions and marginal probabilities. PGMs include various models such as Bayesian networks, which utilize directed acyclic graphs, and Markov networks, which employ undirected graphs to represent relationships. These models are widely used in fields like machine learning, artificial intelligence, and bioinformatics for tasks such as prediction, diagnostics, and decision-making under uncertainty.

Pre-requisites:

All Engineering Mathematics & Machine Learning

Course Objectives:

- Understand the principles of probability including random variables, distributions, expectation, and variance, to model and analyze uncertainty in various contexts.
- Understand the fundamental concepts and algorithms of graph theory, enabling the analysis and optimization of networks and relational structures.
- Learn to construct and use Bayesian networks for representing probabilistic dependencies, performing inference, and making data-driven decisions.
- Understand and apply Markov network models to capture and analyze local dependencies in undirected graphs for complex system modeling.
- Gain proficiency in modeling and analyzing sequential and time-series data using Hidden Markov Models.
- Explore practical applications of probabilistic graphical models across machine learning, artificial intelligence, and bioinformatics, developing skills to solve real-world problems.

Course Outcomes:

Learner will be able to:
CO1: Understand the basic concepts of Probability theory and Graph theory.
CO2: Learn and apply Bayesian networks for representing probabilistic dependencies, performing inference, and making data-driven decisions.
CO3: Understand and utilize Markov network models to represent joint distributions and local dependencies, enhancing their analytical skills for complex systems.
CO4: Gain proficiency in modeling and analyzing sequential and time-series data using Hidden Markov Models,
CO5: To make inferences, learning, actions and decisions while applying probabilistic models.
CO6: Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Probability & Graph Theory	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Probability Axioms and Properties, Conditional Probability and Independence, Discrete Random Variables: Binomial, Poisson, Continuous Random Variables: Uniform, Normal, Continuous Spaces, Expectation, Variance and Covariance. Introduction to Graphs: Graph Definitions and Types, Graph Representation: Adjacency Matrix and List, Subgraphs, Paths and Trails, Cycles and Loop.	4
2	Bayesian Network Model and Inference	Directed Graph Model: Bayesian Network-Structure and Semantics, Exploiting Independence Properties, Naive Bayes Model, Bayesian Network Model, Basic Independencies in Bayesian Networks, Conditional Independence and d-Separation, Bayesian Network Semantics, Graphs and Distributions. Exact inference: Variable Elimination, Conditioning, CPD's and its types, Inference with Structured CPDs.	6
3	Markov Network Model and Inference	Undirected Graph Model: Markov Model-Structure and Components of Markov Networks, Parameter Estimation Techniques, Gibb's distribution, Reduced Markov Network, Markov Network Independencies.	6

		Exact inference variable elimination: Graph Theoretical Analysis for Variable Elimination, Conditioning.	
4	Hidden Markov Model and Inference	Structure of HMM: States, Observations, Probabilities, Template Based Graph Model: HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	6
5	Learning and Taking Actions and Decisions	Learning Graphical Models: Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery. Learning as Optimization: Empirical Risk, over fitting, Generalization, Evaluating Generalization Performance, selecting a Learning Procedure, Goodness of fit, Learning Tasks. Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks. Causality: Conditioning and Intervention, Correlation and Causation, Causal Models, Structural Causal Identifiability, Mechanisms and Response Variables, Learning Causal Models. Utilities and Decisions: Maximizing Expected Utility, Utility Elicitation. Structured Decision Problems: Decision Tree.	6
6	Applications	Application of Bayesian Networks: Classification, Forecasting, Decision Making. Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization. Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	2
		Total	**30**

Textbooks:

1. Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques",
2. Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2).
3. David Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 1st edition, 2011.
4. Martin Wainwright and Michael Jordan, M., "Graphical Models, Exponential Families, and Variational Inference", 2008.

Reference books:

1. Finn Jensen and Thomas Nielsen, "Bayesian Networks and Decision Graphs (Information Science and Statistics)", 2nd Edition, Springer, 2007.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Course Name: Probabilistic Graphical Model Lab

Course Code: EC29P

Category: PEC (Data Analytics)

Preamble:

In PGM practical sessions, students will delve into the fundamental concepts and applications of probability theory, graph theory, Bayesian networks, Markov networks, and hidden Markov models. Through hands-on exercises and projects, they will gain proficiency in simulating probabilistic outcomes, implementing graph algorithms for traversal and optimization, constructing Bayesian networks from data, performing inference in Markov networks, and decoding sequences using hidden Markov models. These practical's aim to bridge theoretical understanding with practical skills, equipping students with the tools to analyze real-world data, model complex systems, and make informed decisions in uncertain environments

Pre-requisites:

Skill Based Lab-Python Programming

Course Objectives:

- Implement simulations and analyze real-world data to understand and apply fundamental probabilistic concepts.
- Apply graph algorithms to solve optimization problems and analyze network structures in various applications.
- Construct Bayesian networks & Markov Network models from data and perform probabilistic inference for decision-making under uncertainty.
- Implement sequence analysis algorithms to decode hidden states and apply HMMs in pattern recognition tasks.

Course Outcomes:

Learner will be able:
CO1: To simulate and analyze probabilistic phenomena, applying statistical methods to real-world data. CO2: To apply graph algorithms to solve problems in connectivity, shortest paths, and network flows, demonstrating analytical skills in network analysis.
CO3: Evaluate Bayesian networks from data, performing probabilistic inference and decision analysis in uncertain environments.
CO4: Use factor graphs and inference algorithms to model and analyze complex probabilistic relationships in data.
CO5: Implement algorithms for sequence analysis, decode hidden states using HMMs, and apply them in tasks such as speech recognition and biological sequence analysis.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

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

Suggested List of Practical's:

Sr No.	Title of Practical's
1	Experiment on Probability Theory
2	Experiment on Graph Theory
3	Experiment on Bayesian Network Modelling
4	Experiment on Markov Chain Modeling
5	Experiment on HMM
6	Experiment on Maximum Likelihood Estimation
7	Experiment on Decision Making using Decision Trees
8	Experiment on Learning with Optimization

Detailed Syllabus of IOT Track – Sem V & VI

Course Name: Modern Sensors for Internet of Things

Course Code: EC23T

Category: PEC (IOT)

Preamble:

This course introduces students to the fundamental principles and applications of sensors in various engineering fields. It covers different types of sensors, their working mechanisms, and their integration into systems, including IoT, embedded systems, and other fields.

Pre-requisites: Nil

Course Objectives:

- Understand the basic principles and classifications of sensors.
- Learn about various types of sensors and their applications.
- Design and implement sensor systems in practical scenarios.
- Integrate sensors with IoT and embedded systems.
- Explore the use of sensors in biomedical applications

Course Outcomes:

Student will be able to:
CO1: Understand fundamentals of Sensors and their characteristics.
CO2: Use different type sensors in Embedded and IoT applications.
CO3: Apply knowledge of conditioning in the design of data acquisition system.
CO4: Create a small sensor network using knowledge of communication protocols.
CO5: Understand concept of communication protocols.
CO6: Designing small applications using one or more sensor.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Sensors Fundamentals and Characteristics	Sensor Classification, Physical Principles of Sensors- Resistive, capacitive, inductive sensors, Optical, magnetic, and thermal sensors, Sensor Characteristics, Performance and Types, Error Analysis characteristics- Sensitivity, accuracy, precision, range, and resolution. Response time and stability, Applications in various fields and criteria to select sensor	5
2	Types of sensors	Optical Sensors- Photodetectors and phototransistors, Fiber optic sensors, Imaging sensors. Mechanical Sensors- Strain gauges and pressure sensors, Accelerometers and gyroscopes, Ultrasonic sensors. Chemical and Biological Sensors- Electrochemical sensors, gas sensors, humidity and temperature sensors, Biosensors	6
3	Data acquisition and Signal Conditioning	Analog and Digital data acquisition system, Data logger, Amplification, filtering, and Analog-to-Digital conversion, Noise reduction techniques, Calibration methods	5
4	Wireless Sensor Networks	Basics of wireless communication, Network topologies and protocols, Bluetooth, ZigBee, Ultra Wide Band (UWB), Near Field Communication (NF) and RFID, WiFi and IEEE 802.11architecture, applications in IoT.	6
5	IoT Systems Integration and communication protocols	Introduction to IoT, Integrating sensors with microcontrollers (e.g., Arduino, Raspberry Pi), Communication protocols (I2C, SPI, UART),	4
6	Sensor applications	On board automobile sensing system, Home automation and Environment monitoring system, Biomedical sensing system, Radio sensing for industrial applications,	4
Total			**30**

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212

4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things",Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Modern Sensors for Internet of Things Lab

Course Code: EC23P

Category: PEC (IOT)

Preamble:

This course introduces students to different types of sensors, their working mechanisms, and their integration into systems. Selection and interfacing of a sensor in the IoT and embedded systems design.

Pre-requisites: Nil

Course Objectives:

- To understand various sensors type and their characteristics.
- To understand different type of sensors and their application.
- To understand communication protocol and their use in sensor network.
- To understand various types communication protocols required in IoT applications and their characteristics.
- To learn to develop small IoT or Embedded system using sensor.

Course Outcomes:

Student will be able to:

CO1: Identify and test the characteristics of various sensors.
CO2: Select most appropriate sensor and design required signal condition for the same.
CO3: Implement communication and wireless communication protocol in IoT application.
CO4: Design and implement small IoT or Embedded system.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSE	ESE	Total
Practical	25	-	25	050

Suggested List of Practical:

- Identification of sensor and their important characteristics.
- Testing and Calibration of sensor.
- Identification of Sensitivity, range, resolution, Response time parameters of sensors
- Develop a system to record one of the physical parameter using appropriate sensor
- Develop a system to communicate one or more physical parameters using wireless

communication.

- Develop a system to communicate one or more physical parameters using communication protocol.
- Design and develop a small IoT or system using one or more sensor and a communication procol.

Textbooks:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
5. Sensors and Transducers" by Ian R. Sinclair - Comprehensive introduction to various sensors and their applications.

Reference Books:

1. Edited by Qusay F Hasan, Atta ur rehman Khan, Sajid A madani, "Internet of Things Challenges, Advances, and Application", CRC Press
2. Triethy HL - Transducers in Electronic and Mechanical Designs, Mercel Dekker, 2003
3. Gerd Keiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. 212
4. John G Webster, Halit Eren, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Taylor and Fransis Group, New York.
5. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
6. Nathan Ida, "Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction", Second Edition, IET Control, Robotics and Sensors Series 127, 2020

Course Name: Principles of Internet of Things

Course Code: EC27T

Category: PEC (IOT)

Preamble:

The world around us is becoming increasingly interconnected. Internet of Things (IoT), a rapidly evolving field that's transforming the way we live, work, and interact with the world around us. This course will be your deep dive into the foundations of IoT. Students will delve into the language of sensors and actuators, uncover the secrets of communication between devices, and understand the challenges and opportunities that come with a connected world. By the end, students will gain a solid understanding of the fundamental building blocks of IoT and be well-equipped to navigate this exciting and ever-growing field. Students will also be able to build use cases and Mini projects

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and Microcontroller

Course Objectives:

- To Understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- To Explore different Protocols used in IoT Communication
- To Gain a foundational knowledge of common IoT Interfaces.
- To Develop critical thinking skills to analyze proper selection of Boards
- To build practical skills by programming or building a simple IoT project to solidify your understanding**.**

Course Outcomes:

Student will be able to:
CO1: Understand the concept of IoT and its key components of IoT.
CO2: Understand different IoT Communication Protocols.
CO3: Understand different hardware Communication Protocols.
CO4: Select appropriate development boards for Building IOT Applications.
CO5: Develop programs for IoT application.
CO6: Develop creative applications of IoT technology in chosen fields.

Course Scheme:

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

Assessment Guidelines:

Head of learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. 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 Internet of Things	1.1 Definition and characteristics of IoT 1.2 History and evolution of IoT 1.3 Architectural layers of an IoT system (perception, network, application, data management) 1.4 Levels of IoT	5
2	Communication Protocols	2.1 IoT Edge to Cloud protocols: HTTP, REST APIs, WebSocket, MQTT, COAP, Comparison of Protocols.M2M Communication Protocols, 2.2 Bluetooth BR/EDR and Bluetooth low energy. RFID IoT System , RFID IoT Network Architecture, ZigBee IP/ZigBee SE2.0, Wifi(WLAN), 2.3 Message Communication protocols for connected devices Data exchange formats: JSON & XML	5
3	Sensor Interfaces	3.1 Digital Interfaces: UART, Serial Peripheral Interface (SPI), I2C (Inter-Integrated Circuit), Controller Area Network (CAN), Middleware Technologies, 3.2 Communication Protocols and Models. Practical Components Programming with interface in Arduino, MBed and Raspberry Pi	5
4	Hardware Fundamentals	4.1 Introduction to various sensors (temperature, humidity, pressure, motion, etc.) 4.2 Actuators and their types (solenoids, motors, relays) 4.3 Microcontrollers and development boards (e.g., Arduino, Raspberry Pi) 4.4 Interfacing sensors and actuators with microcontrollers 4.5 Introduction to embedded system design principles	5
5	Software Development for IoT	5.1 Introduction to programming languages for IoT (e.g., Python, C++) 5.2 Data acquisition, processing, and visualization techniques 5.3 Introduction to IoT platforms and frameworks Security considerations in IoT applications	5
6	IOT Applications and USE Cases	Case Studies Illustrating IoT Design in Applications like Home Automation, Smart Cities, Environment, Agriculture, Healthcare.	5
Total			**30**

Textbooks:

1. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill Education, First edition

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Course Name: Principles of Internet of Things Lab

Course Code: EC27P

Category: PEC (IOT)

Preamble:

This lab will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and Microcontroller

Course Objectives:

- To Understand interfacing of Sensors & actuators
- To identify how IoT differs from traditional data collection systems.
- To explore the interconnection and integration of the physical world and able to design & develop IOT Devices.

Course Outcomes:

Student will be able to:
CO1: Adapt different techniques for data acquisition using various IoT sensors for different applications.
CO2: Demonstrate the working of actuators based on the collected data.
CO3: Use different IoT simulators and correlate working of IoT protocols.
CO4: Select appropriate development board for IoT application.
CO5: Implement IoT protocols like MQTT for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.
CO6: Develop use cases for Different IoT Applications.

Course Scheme:

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

Assessment Guidelines:

Head of learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned in the above table. 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.

Suggested List of Practical's:

1. To study and implement interfacing of different IoT sensors with Raspberry Pi/Arduino/NodeNCU
2. To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper word)Modulation and Demodulation of Binary Frequency Shift Keying.
3. To study and demonstrate use of IoT simulators (like Beviswise) on any real time device (LED/stepper motor)
4. To study MQTT Mosquitto server and write a program on Arduino/Raspberry Pi to publish sensor data to MQTT broker.
5. Interfacing to Wireless Communication Devices like Bluetooth , LoRA
6. Install OS in Raspberry Pi
7. Predictive Maintenance in Industrial Automation Systems
8. Study different hardware Boards used in IoT applications

Mini Projects / Case Study :-
Select any one case study (in a group of 2-3) and perform the experiments 5 to 10. The sample case studies can be as follows:
1. Smart home automation system
2. Healthcare management system
3. Smart traffic management system & so on…
4. Write a program on Raspberry Pi to push and retrieve the data from cloud like thing speak, things board, AWS, Azure etc.

Textbooks / Reference Books

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly publication, 2016
2. Joakim Verona," Practical DevOps", PACKT publishing, 2016
3. Honbo Zhou," The internet of things in the cloud", CRC press, Taylor and Francis group, 2012
4. Perry Lea," Internet of things for architects", PACKT publishing, 2018

Course Name: Embedded System Design with Tiny Operating System (OS)

Course Code: EC31T

Category: PEC (IOT)

Preamble:

Embedded System is used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course blends the concepts of embedded systems with machine learning for developing smart and dedicated applications for requirements of IoT. It introduces the fundamental concepts of operating systems and use of operating system in the development of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Understand fundamental concepts of advanced 32 bit micro-controllers.

CO2: Demonstrate the fundamental concepts of embedded system design

CO3: Use communication interface for design of embedded system.

CO4: Understand concept of Real Time Operating Systems (RTOS) for embedded system design.

CO5: Understand fundamental concepts of tiny machine learning.

CO6: Use concept of tiny machine learning for design of embedded systems.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSE	ESE	Total (Passing @40% of total)
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	ARM 7 family and Programming	Introduction, features, basic architecture, Cortex family, register organization with different registers like CPSR	6
2	Introduction to embedded systems	Introduction and different examples/applications, classification of embedded systems, design metrics of an embedded systems, embedded system design life cycle, processor technology for embedded systems, concept of modelling in embedded systems	5
3	Communication Protocols for embedded systems	UART, SPI, I2C, CAN with details like pins, working, timing diagram and common applications, introduction to other communication protocols like zig-bee and Wi-Fi.	6
4	Real Time Operating Systems	Basic concept of operating system, process management with scheduling and related issues, process synchronization with algorithms, concept of threading	6
5	Machine Learning Fundamentals	Concept of machine learning, fundamentals of tiny ML, design and challenges, Building and training machine learning model, Convolutional Neural Networks	4
6	Application Development	Building applications and deployment of model	3
Total			**30**

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment:

1. **ISA (In-Semester-Assessment):** In semester assessment will carry total 15 marks. It will consist of weekly graded assignments based on modules (each carrying 10 marks). The assignments are self-study work and need to be completed by individual students separately. Every student will be submitting four completed assignments. Students are encouraged to develop their own problem statements and devise a proper method / solution. Importance will be given to the concept understanding and applying it to solve the industrial problem using coding.

2. **MSA (Mid-Semester-Assessment):** Mid Semester Assessment will consist of three mid semester internal theory test carrying 20 marks based on completion of minimum modules. This test will be common for all the students. ***Repeat examination will not be conducted.***

3. **ESE (End-Semester-Examination):** End Semester Examination will be conducted for total of 40 marks based on the completion of remaining modules post completion of mid semester examination or an entire syllabus. This test will be common for all the students.

Course Name: Embedded System Design with Tiny Operating System (OS) Lab

Course Code: EC31P

Category: PEC (IOT)

Preamble:

Embedded System is a used for developing a dedicated task or application. Internet of Things (IoT) is an upcoming technology based on the base of embedded systems. Machine learning (ML) is also an upcoming technology and concepts of ML are used in many applications. This course enables learner to use concept of tiny machine learning and Real Time Operating System for design of embedded systems.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand the fundamentals of ARM 7 family.
- To understand concepts of embedded systems.
- To understand communication interface for embedded systems.
- To understand working with Real Time Operating Systems (RTOS).
- To understand fundamental concepts of tiny machine learning.
- To use tiny machine learning for embedded systems.

Course Outcomes:

Student will be able to:

CO1: Use concepts of advanced 32 bit micro-controllers.

CO2: Apply the fundamental concepts of embedded system design.

CO3: Use communication interface for design of embedded system.

CO4: Use Real Time Operating Systems (RTOS) for embedded system design.

CO5: Use fundamental concepts of tiny machine learning.

CO6: Apply concept of tiny machine learning for design of embedded systems.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSE	ESE	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following application

1. Smart population count system
2. Smart traffic light system
3. Smart temperature monitoring system
4. E notice board
5. E display
6. Smart elevator system

Textbooks:

1. Embedded System Architecture, Programming & Design (Tata McGraw Hill Publication, Third Edition)- Raj Kamal
2. An Embedded Software Primer- David E. Simon
3. Embedded Real Time Systems Programming- Sriram V. Iyer, Pankaj Gupta
4. MicroC/OS-II, Indian Low price Edition 2002- Jean J. Labrose
5. Embedded Real Time Systems: Concepts, design & Programming (Dreamtech Publication)- K. V. K. K. Prasad

Reference Books:

1. Embedded System Design: A Unified Hardware/Software Introduction (Wiley Publication)- frank Vahid, Tony Givargis
2. ARM System-on-Chip Architecture (Pearson 2005)- Steve Furber
3. Tiny Machine Learning - Pete Warden and Daniel Situnayake
4. Rajib Mall: "Real Time Systems theory and practice", Pearson 2008

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction.
5. ***Student will lose the marks if he or she remains absent for the Laboratory P***

Detailed Syllabus of VLSI Track – Sem V & VI

Course Name: Digital System Design

Course Code: EC24T

Category: PEC (VLSI)

Preamble:

Digital System design is a study of Programmable Logic Devices, Sequential Circuit Design, Introduction to VERILOG, Levels of Abstraction on VERILOG, and Design of Combinational and Sequential Circuits. This course aims to equip students with the necessary theoretical knowledge and practical skills required in the field of digital logic design and hardware description languages. Through a combination of theoretical lectures, practical demonstrations, and hands-on exercises, students will develop a comprehensive understanding of digital logic design principles and gain proficiency in using hardware description languages for circuit design and simulation.

Pre-requisites:

- Digital Electronics
- Electronic Devices and circuits.
- Basic of VLSI Design

Course Objectives:

- To explore the classification, concepts, and implementation of Programmable Logic Devices (PLDs)
- To learn about the building blocks of synchronous and asynchronous sequential circuits.
- To introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

CO1: Design hardware that can be implemented on a variety of Programmable Logic Devices.
CO2: Design different sequential circuits using Finite state machine.
CO3: Understand basic entities of Verilog HDL.
CO4: Use various abstraction levels of Verilog HDL for a given application.
CO5: Design the combinational and sequential logic circuits using various constructs in Verilog

Course Scheme:

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

Assessment Guidelines:

Head of learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned in the above table. 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.	Unit No.	Content	Hrs.
1		**Programmable Logic Devices.**	4
	1.1	Classification of Programmable Logic Devices, Concept and Implementation of PROM, PLA, and PAL. CPLD and FPGA	
	1.2	Block diagram of CPLD, General Structure of FPGA, Introduction to XILINX FPGA family.	
2		**Sequential Circuit design using state machines.**	8
	2.1	Building blocks of Synchronous and Asynchronous sequential circuits. General Model of Synchronous Sequential circuit, Moore, and Mealy Circuits.	
	2.2	Analysis Synchronous and Asynchronous sequential circuits: State Table, State diagram, state equation, state reduction, state assignment and logic realization Design of synchronous sequential circuits using various flip flops.	
3		**Introduction to VERILOG.**	4
	3.1	Lexical Conventions, Methodology: Top Down & Bottom Up Modules, Data types, Arrays, Ports, Variables and Constants, Operator types, Functions and Tasks, Test Bench.	
	3.2	VERILOG Primitives. VERILOG Language formal syntax	
4		**Levels of Abstraction on VERILOG**	6
	4.1	Gate-Level Modelling: Modelling using basic Verilog gate primitives, description of and/or and buff/not type gates, rise, fall and turn-off delays, min, max, and typical delays.	
	4.2	Dataflow Modelling: Continuous assignments, delay specification, expressions, operators, operands, operator types.	
	4.3	Behavioural Modelling: Structured procedures, initial and always, blocking and nonblocking statements, delay, control, generate statement, event control, conditional statements, multiway branching, loops, sequential and parallel block	
5		**Design of Combinational and Sequential Circuits**	8
	5.1	Design of Adders, Multiplexers, Demultiplexers, Encoders and Decoders using VERILOG.	
	5.2	Design of various Flip-Flops, Counters and Shift registers using VERILOG.	
	5.3	Design of ALU, IIR & FIR Filters using VERILOG.	
Total			**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Fundamentals of Digital Design	M. Senthil Sivakuma	S.Chand	4th Edition 2023	1,2,
2	Verilog HDL	Samir Palnitkar	Pearson Education	2nd Edition 2018	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Design Principal and Practises.	John F. Wakerly	PHI	4th 2006	1,2,
2	Digital Design with RTL design VHDL and VERILOG	Frank Vahid	Wiley	2011	1,2
3	FPGA Prototyping by VERILOG Examples.	Pong.P.Chu	Wiley	3rd	3,4,5
4	Advanced Digital Design with VERILOG HDL	Michael D. Ciletti.	Pearson	2nd Edition 2018	3,4,5

Course Name: Digital System Design Lab

Course Code: EC24P

Category: PEC (VLSI)

Preamble:

Digital System design is a study of Programmable Logic Devices, Sequential Circuit Design, Introduction to VERILOG, Levels of Abstraction on VERILOG, and Design of Combinational and Sequential Circuits. This course aims to equip students with the necessary theoretical knowledge and practical skills required in the field of digital logic design and hardware description languages. Through a combination of theoretical lectures, practical demonstrations, and hands-on exercises, students will develop a comprehensive understanding of digital logic design principles and gain proficiency in using hardware description languages for circuit design and simulation.

Pre-requisites:

- Digital Electronics
- Electronic Devices and circuits.
- Basic of VLSI Design

Course Objectives:

- To explore the classification, concepts, and implementation of Programmable Logic Devices (PLDs)
- To learn about the building blocks of synchronous and asynchronous sequential circuits.
- To introduced to VERILOG, a hardware description language widely used in digital design.
- Design various Combinational and Sequential circuits using VERILOG.

Course Outcomes:

CO1: Design hardware that can be implemented on a variety of Programmable Logic Devices.
CO2: Design different sequential circuits using Finite state machine.
CO3: Understand basic entities of Verilog HDL.
CO4: Use various abstraction levels of Verilog HDL for a given application.
CO5: Design the combinational and sequential logic circuits using various constructs in Verilog

Course Scheme:

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

Assessment Guidelines:

Head of learning	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by

a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1,2,3,4,5	Study of simulation and synthesis using tools	Make student aware of different simulation and synthesis tools	1,2,3,4,5
2	1,2,3,4,5	Simulation and implementation of basic Logic Gates using VIVADO and SPRTAN7 FPGA.	Make modules of different logic gates which can be used in the hierarchical description of circuits.	1,2,3,4,5
3	1,2,3,4,5	Simulation and implementation of Half and Full Adder using VIVADO and SPRTAN7 FPGA.	Make modules of different adder which can be used in the hierarchical description of circuits.	1,2,3,4,5
4	1,2,3,4,5	Simulation and implementation of Multiplexers and Demultiplexers using VIVADO and SPRTAN7 FPGA.	Make modules of different mux and demux circuits which can be used in the hierarchical description of circuits.	1,2,3,4,5
5	1,2,3,4,5	Simulation and implementation of Encoder and Decoder using VIVADO and SPRTAN7 FPGA.	Make modules of different encoder and decoders which can be used in the hierarchical description of complex circuits	1,2,3,4,5
6	1,2,3,4,5	Simulation and implementation of Parallel Binary Adder using VIVADO and SPRTAN7 FPGA.	Make modules of different 4 -bit parallel adder which can be used in the hierarchical description of complex circuits. To determine delay in carry generation.	1,2,3,4,5
7	1,2,3,4,5	Simulation and implementation of Carry Look ahead Adder using VIVADO and SPRTAN7 FPGA.	Implementation of carry generation circuit and observe the speed improvement as compared to a ripple carry adder	1,2,3,4,5
8	1,2,3,4,5	Simulation and implementation of various flip-flops using VIVADO and SPRTAN7 FPGA.	Make modules of different various flip flops which can be used in the hierarchical description of complex circuits.	1,2,3,4,5
9	1,2,3,4,5	Simulation and implementation of Counters using VIVADO and SPRTAN7 FPGA.	Implement different counters and compare their performance	1,2,3,4,5
10	1,2,3,4,5	Simulation and implementation Shift Registers using VIVADO and SPRTAN7 FPGA.	Demonstrate PIPO, SISO SIPO and PISO operation	1,2,3,4,5
11	1,2,3,4,5	Simulation and implementation of basic ALU using VIVADO and SPRTAN7 FPGA.	Demonstrate concepts related to ALU design and implementation of various arithmetic and logical functions	1,2,3,4,5

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Fundamentals of Digital Design	M. Senthil Sivakuma	S.Chand	4th Edition 2023	1,2,
2	Verilog HDL	Samir Palnitkar	Pearson Education	2nd Edition 2018	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Design Principal and Practises.	John F. Wakerly	PHI	4th 2006	1,2,
2	Digital Design with RTL design VHDL and VERILOG	Frank Vahid	Wiley	2011	1,2
3	FPGA Prototyping by VERILOG Examples.	Pong.P.Chu	Wiley	3rd	3,4,5
4	Advanced Digital Design with VERILOG HDL	Michael D. Ciletti.	Pearson	2nd Edition 2018	3,4,5

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Course Name: Advanced VLSI Design

Course Code: EC28T

Category: PEC (VLSI)

Preamble:

This course delineates a comprehensive course on Advanced VLSI Design, focusing on key topics essential for understanding and mastering contemporary semiconductor design methodologies and techniques. Through a structured approach, this course aims to equip students with the knowledge and skills necessary to navigate the complexities of VLSI design, including delay estimation, clocking methodologies, semiconductor manufacturing processes, semiconductor fabrication, and novel device technologies.

Pre-requisite:
- Digital Electronics
- Electronic Devices and Circuits
- Basics of VLSI Design

Course Objectives:

- To provide knowledge of fundamental building blocks of IC fabrication
- To design basic CMOS circuit layouts using Lambda design rules
- To be familiar with various VLSI technologies and novel devices

Course Outcomes:
After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of delay estimation using concept of logical effort
CO2: Understand different VLSI Clocking and System Level Physical design issues.
CO3: Explain semiconductor manufacturing and crystal growth techniques.
CO4: Demonstrate a clear understanding of various MOS fabrication processes.
CO5: Study various VLSI technologies and novel devices.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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.	Unit No.	Contents	Hrs.
1		**Delay Estimation**	07
	1.1	RC Delay Models, Elmore Delay Model, Linear Delay Model, interconnect scaling and crosstalk	
	1.2	Logical Effort and Transistor Sizing: Delay in a logic gate, Delay in a Multi-stage Logic Network, Choosing the best number of stages.	
2		**VLSI Clocking and System Level Physical design**	06
	2.1	Clock Generation, Stabilization and Distribution	
	2.2	Clocking Styles: Clocked Cascade, Timing Circle, Clock Skew and Clock Jitter	
	2.3	IO pads and Power Distribution: ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme.	
3		**Semiconductor manufacturing requirements and Crystal growth**	05
	3.1	Semiconductor Manufacturing: Semiconductor technology trend, clean rooms, Wafer cleaning and Gettering	
	3.2	Crystal growth techniques: Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	
4		**Semiconductor Fabrication Processes**	06
	4.1	Oxidation, Deposition, Diffusion, Ion Implantation, Etching, Lithography, Metallization and contacts	
	4.2	CMOS Process Flow: N well, P-well and Twin tub, CMOS Latch Up Design rules: Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
5		**Novel Devices**	06
	5.1	Multi-gate Devices: Various multi-gate device configurations-double gate, triple gate (Fin-FET) and High K-Dielectrics	
	5.2	Nanowire: Concept, VLSI method of fabrication, Nanowire FETs	
	5.3	CNT FET: Introduction to Graphene and CNTFET structure	
		Total	**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Logical Effort: Designing Fast CMOS Circuits	Ivan Sutherland and Bob Sproull,	The Morgan Kaufmann Series in Computer Architecture and Design	4th	1
2	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2
3	Silicon VLSI Technology	James D. Plummer, Michael D. Deal and Peter B. Griffin,	Pearson	5th	3,4,5
4	VLSI Fabrication Principles‖,	Sorab K. Gandhi	Wiley	5th	3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
2	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
3	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
4	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
5	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
7	Advanced Semiconductor Memories: Architectures, Designs, and Applications	Ashok K. Sharma,	Wiley Publication	4th	4
8	Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond	Denny D.Tang, Chi-Feng Pai,	Wiley online Library	2nd	4
9	Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications.	Daniele Ielmini, Rainer Waser,	Wiley online Library	3rd	4

Course Name: Advanced VLSI Design Lab

Course Code: EC28P

Category: PEC (VLSI)

Preamble:

This course delineates a comprehensive course on Advanced VLSI Design, focusing on key topics essential for understanding and mastering contemporary semiconductor design methodologies and techniques. Through a structured approach, this course aims to equip students with the knowledge and skills necessary to navigate the complexities of VLSI design, including delay estimation, clocking methodologies, semiconductor manufacturing processes, semiconductor fabrication, and novel device technologies.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Basics of VLSI Design

Course Objectives:

- To provide knowledge of fundamental building blocks of IC fabrication
- To design basic CMOS circuit layouts using Lambda design rules
- To be familiar with various VLSI technologies and novel devices

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of delay estimation using concept of logical effort
CO2: Understand different VLSI Clocking and System Level Physical design issues.
CO3: Explain semiconductor manufacturing and crystal growth techniques.
CO4: Demonstrate a clear understanding of various MOS fabrication processes.
CO5: Study various VLSI technologies and novel devices.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

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

assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested list of Practical:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	Comparison of various delay models using CADENCE	Delay estimation using different delay models	CO1
2	1	Calculation of delay offered by FO4 inverter	Concept of estimating the least delay.	CO1
3	3	Simulation of oxidation process using ATCAD Lab of Nanohub.org.in	Oxidation process	CO3
4	3	Simulation of diffusion process using ATCAD Lab of Nanohub.org.in	Diffusion process	CO3
5	4	Design of CMOS inverter layout using Cadence tool	CMOS logic	CO4
6	4	Introduction to CADENCE for VLSI Design. Draw layout for given aspect ratio and implement CMOS inverter, CMOS NAND, NOR logic gates using CADENCE	CMOS logic	CO4
7	4	Implement half and full adder circuits and CADENCE (for layout) and verify functionality of the circuit	CMOS logic	CO4
8	5	Simulation of double gate FinFET using MugFET simulation using ATCAD lab of Nanohub. (nanohub.org.in)	FinFet working	CO5
9	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5
10	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5

Course Name: Analog IC Design

Course Code: EC32T

Category: PEC (VLSI)

Preamble:

This course focuses on the process of designing analog integrated circuits (ICs) using VLSI techniques. Analog circuits process continuously varying signals, in contrast to digital circuits that manipulate discrete binary values (0s and 1s). Analog VLSI Design involves creating circuits that perform functions such as amplification, filtering, signal conditioning, and analog-to-digital conversion. In Analog VLSI Design, engineers integrate multiple analog functions onto a single chip, often alongside digital components, to create complex systems-on-chip (SoCs) or mixed-signal integrated circuits. Analog VLSI Design poses unique challenges compared to digital design due to the inherent complexities of analog signals and the sensitivity of analog circuits to variations in manufacturing processes, temperature, and voltage. Engineers must carefully consider factors such as noise, distortion, power consumption, and layout parasitic to ensure that the designed circuits meet performance specifications under various operating conditions.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture
- Basics of VLSI Design

Course Objectives:

- To Gain a deep understanding of fundamental analog circuit topologies, including amplifiers, filters, oscillators, and voltage reference.
- To learn the principles of VLSI design, including transistor-level design, layout techniques, and design verification.
- To explore techniques for optimizing analog circuit performance, such as maximizing bandwidth, achieving low noise, and minimizing power consumption.
- To apply theoretical concepts to real-world design projects, culminating in the design and simulation of complex analog integrated circuits.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate the understanding of various building blocks and their use in design of analog circuits.
CO2: Analyze different single stage amplifiers.
CO3: Understand various types of differential amplifiers.
CO4: Design various OPAMP circuits
CO5: Discuss issues related to Analog Layout and design rules.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

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

Module No.	Unit No.	Contents	Hrs.
1		**Analog building blocks**	06
	1.1	Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror.	
	1.2	Voltage References: Band Gap References, General Considerations, Supply-independent biasing, PTAT & CTAT current generation, Temperature independent references and Constant Gm biasing	
2		**Amplifier Fundamentals**	06
	2.1	Single Stage Amplifiers: Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, Frequency response.	
	2.3	Noise: Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages), noise bandwidth, noise figure, noise temperature.	
3		**Differential Amplifiers**	06
	3.1	Differential Amplifiers: Single ended and differential operation, Basic differential pair, large signal and small signal behavior, Qualitative and Quantitative analysis of Common-mode and differential Mode, Frequency response	
	3.2	Differential Pair with MOS Loads, Gilbert Cell, Noise in differential pairs	
4		**MOS Operational Amplifiers**	08
	4.1	Op-amp Design: General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Bandwidth (GBW), Gain Boosting, Common-mode feedback, Input range limitations (ICMR), Slew Rate, Power supply rejection, Noise in op-amps.	
	4.2	Stability and Frequency Compensation: General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op- amps.	
	4.3	Design of single ended and double ended two stage Op-amps	
5		**Analog Layouts**	04
	5.1	General Layout considerations, Design Rules & antenna Effect	
	5.2	Analog Layout techniques: Multi-finger transistors, symmetry, shallow trench Isolation Issues, well proximity effects, reference distribution, passive devices, interconnect, pads and ESD protection.	
		Total	**30**

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	Tata McGraw Hill	2nd	1,2,3,4,5
2	CMOS Circuit Design, Layout, and Simulation	R. Jacaob Baker, Harry W. Li, David E. Boyce	Wiley	2nd	1,2,3,4,5
3	CMOS Analog Circuit Design	P. E. Allen and D. R. Holberg	Oxford University Press	3rd	1,2,3,4,5
4	Analysis and design of Analog Integrated Circuits	Gray, Meyer, Lewis, Hurst	Wiley	5th	1,2,3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Circuit Design, Layout and Simulation	Baker Li Boyce	Wiley	3rd	1,2,3,4,5
2	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
3	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
4	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
5	Basics of CMOS Cell Design	Etienne Sicard and Sonia Delmas Bendhia	Tata McGraw Hill	4th	1,2,3,4,5
6	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
7	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
8	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5

Course Name: Analog IC Design Lab

Course Code: EC32T

Category: PEC (VLSI)

Preamble:

This course focuses on the process of designing analog integrated circuits (ICs) using VLSI techniques. Analog circuits process continuously varying signals, in contrast to digital circuits that manipulate discrete binary values (0s and 1s). Analog VLSI Design involves creating circuits that perform functions such as amplification, filtering, signal conditioning, and analog-to-digital conversion. In Analog VLSI Design, engineers integrate multiple analog functions onto a single chip, often alongside digital components, to create complex systems-on-chip (SoCs) or mixed-signal integrated circuits. Analog VLSI Design poses unique challenges compared to digital design due to the inherent complexities of analog signals and the sensitivity of analog circuits to variations in manufacturing processes, temperature, and voltage. Engineers must carefully consider factors such as noise, distortion, power consumption, and layout parasitic to ensure that the designed circuits meet performance specifications under various operating conditions.

Pre-requisite:

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture
- Basics of VLSI Design

Course Objectives:

- To Gain a deep understanding of fundamental analog circuit topologies, including amplifiers, filters, oscillators, and voltage reference.
- To learn the principles of VLSI design, including transistor-level design, layout techniques, and design verification.
- To explore techniques for optimizing analog circuit performance, such as maximizing bandwidth, achieving low noise, and minimizing power consumption.
- To apply theoretical concepts to real-world design projects, culminating in the design and simulation of complex analog integrated circuits.

Course Outcomes:

After successful completion of the course students will be able to:
CO1: Demonstrate the understanding of various building blocks and their use in design of analog circuits.
CO2: Analyze different single stage amplifiers.
CO3: Understand various types of differential amplifiers.
CO4: Design various OPAMP circuits
CO5: Discuss issues related to Analog Layout and design rules.

Course Scheme:

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

Assessment Guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

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

Suggested list of Practical:

Practical No.	Module No.	Suggested list of Experiments	Topics to be highlighted	CO Map
1	1	Analysis of MOSFETs for analog performance	Effect of Body Bias and Channel Length Modulation	CO1
2	1	Design and simulate various types of current mirror circuits	Design of Current Mirrors and techniques to mitigate the effect of channel length modulation	CO1
3	2	Design and simulate various common source amplifier circuits	Compare various types of common source amplifier	CO2
4	2	Design and simulate various types of Common Drain amplifiers	Compare various types of common drain amplifier	CO2
5	2	Design and simulate various types of Common Gate amplifiers	Compare various types of common gate amplifier	CO2
6	3	Design and simulate differential amplifier	Compare various types of differential amplifier	CO3
7	4	Design and simulate operational transconductance amplifier	Compare various topologies of OPAMPS	CO4
8	5	Generate layout for the simple and cascode current mirror	Layout Design Issues while designing cascode amplifier	CO5
9	5	Generate layout for common source amplifier	Layout Design Issues while designing common source amplifier	CO5
10	5	Generate layout for the differential amplifier	Layout Design Issues while designing differential amplifier	CO5
11	1,2,3,4,5	Simulation of Complete Digital Design Flow in Cadence	Digital Design Flow using Cadence	CO1,2,3,4,5,6
12	1,2,3,4,5	Simulation of Complete Analog Design Flow in Cadence	Analog Design Flow using Cadence.	CO1,2,3,4,5,6

Textbooks:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	Design of Analog CMOS Integrated Circuits	Behzad Razavi	Tata McGraw Hill	2nd	1,2,3,4,5
2	CMOS Circuit Design, Layout, and Simulation	R. Jacaob Baker, Harry W. Li, David E. Boyce	Wiley	2nd	1,2,3,4,5
3	CMOS Analog Circuit Design	P. E. Allen and D. R. Holberg	Oxford University Press	3rd	1,2,3,4,5
4	Analysis and design of Analog Integrated Circuits	Gray, Meyer, Lewis, Hurst	Wiley	5th	1,2,3,4,5

Reference Books:

Sr. No	Textbook Titles	Author/s	Publisher	Edition	Module Nos.
1	CMOS Circuit Design, Layout and Simulation	Baker Li Boyce	Wiley	3rd	1,2,3,4,5
2	Digital Integrated Circuits: A Design Perspective	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic	Pearson Education	2nd	2,3,4,5
3	Introduction to VLSI Circuits and Systems	John P. Uyemura	Wiley India Pvt. Ltd.	Revised 4th Edition	3,4,5
4	CMOS Digital Integrated Circuits Analysis and Design	Sung-Mo Kang and Yusuf Leblebici,	Tata McGraw Hill	Revised 4th Edition	1,2,3,4,5
5	CMOS VLSI Design: A Circuits and Systems Perspective	Neil H. E. Weste, David Harris and Ayan Banerjee,	Pearson Education	5th	1,2,3,4,5
6	Analysis and Design of Digital Integrated Circuits	David Hodges, Horace Jackson, Resve Saleh.	McGraw-Hill, Inc.	3rd	1,2,3,4,5
8	Basic VLSI Design	Douglas A Pucknell, Kamran Eshraghian,	Prentice Hall of India Private Ltd.	3rd	1,2,3,4,5

Appendix-B

Guidelines for Award of Honours/ Minor Degree Programme

Honours and Minor Degree programme is introduced in order to facilitate learners to enhance the depth of knowledge, diversity, breadth and skills in emerging fields. An Honours or Minor Degree typically refers to a higher level of academic achievement either for research orientation or for improving employability. Learners can select any Honours or Minor Degree programme as per his/her choice.

In our curriculum, learners can choose to avail Honours/ Minor Degree programme by completing requirements of 18 credits, which will be over and above the minimum credits required for B.Tech. degree i.e. credit requirement for the award of degree programme and Honours/ Minor degree programme are required to be explicitly carried out. Learners shall opt for Honours or Minor specialisations during the break of Semester 5 and Semester 6. **Learners may complete the B.Tech. degree programme without opting for Honours or Minor degree programme** i.e. opting for Honours/ Minor Degree programme is not mandatory as a part of B.Tech. degree programme

For Honours Degree, learner shall select Honours programme offered by his/her own department. Alternatively, for Minor Degree, learner shall select one of the two programmes offered by INFT department.

Eligibility Criteria

- Basic eligibility for opting for Honours/Minor shall be minimum CGPA of 6.75 at the end of 4th semester and no pending failure at the time of admission to semester 5.
- If student has already completed any course(s) that is listed in the chosen Honours/Minor degree programme, as additional learning course(s), then the transfer credits for such course(s) can be carried out towards Honours/ Minor degree programme.
- For a student to get Honours/ Minor degree, it is mandatory that the student completes the relevant courses before graduating.

Syllabus Scheme Template

Sr. No.	Course		Head of Learning	Preferred Semester	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name				ISA	MSE	ESE	
1	XXXX	Industry Interaction	Theory	Break of Sem5 and Sem6	1	25	-	-	025
2	XXXX	Honours / Minor Degree Course 1	Theory	6	2	15	20	40	075

	XXXX	Honours / Minor Degree Course 1 Lab	Practical	6	1	25	-	25	050
3	XXXX	Survey Report/ Paper	Theory	Break of Sem6 and Sem7	2	50	-	25	075
4	XXXX	Honours / Minor Degree Course 2	Theory	7	2	15	20	40	075
	XXXX	Honours / Minor Degree Course 2 Lab	Practical	7	1	25	-	25	050
5	XXXX	Capstone Project-I	Practical	7	3	50	-	50	100
6	XXXX	Seminar	Theory	Break of Sem7 and Sem8	1	25	-	25	50
7	XXXX	Honours / Minor Degree Course 3	Theory	8	2	15	20	40	075
	XXXX	Honours / Minor Degree Course 3 Lab	Practical	8	1	25	-	25	050
8	XXXX	Capstone Project-II	Practical	8	4	75	-	50	125
Total					**20**				

Detailed list of courses under each Honours/ Minor Degree Programme:

- Electronics and Computer Science Department learners can refer to the list of Honours/Minor Degree Programme and their corresponding courses in the Appendix-C.

Appendix-C

Honours/ Minor Degree Programmes offered by Department of Electronics and Computer Science

The Department of Electronics and Computer Science offers the below listed Honours/Minor Degree Programme for learners of Electronics and Computer Science.

Honours Degree Programmes Offered.

Sr.No.	Honours Degree Programme	Department offering Honours
1	Advanced Artificial Intelligence and Machine Learning	Electronics and Computer Science
2	Advanced Data Analytics	Electronics and Computer Science
3	Advanced Internet of Things	Electronics and Computer Science

Minor Degree Programmes Offered.

Sr.No.	Minor Degree Programme	Department offering Minor
1	UI/UX	Information Technology
2	Blockchain	Information Technology

Courses to be successfully completed as a part of Honours Degree Programme

1. Advanced Artificial Intelligence and Machine Learning

Semester	Course Code	Course Name
VI	EC54T	Ethics in AI
VI	EC54P	Ethics in AI Lab
VII	EC58T	Scalable ML and BDA
VII	EC58P	Scalable ML and BDA Lab
VIII	EC62T	Generative model and GenAI
VIII	EC62P	Generative model and GenAI Lab

2. Advanced Data Analytics

Semester	Course Code	Course Name
VI	EC55T	Data Visualization Using R-Programming
VI	EC55P	Data Visualization Using R-Programming Lab
VII	EC59T	Time Series and Forecasting
VII	EC59P	Time Series and Forecasting Lab
VIII	EC63T	Data Ethics and Privacy
VIII	EC63P	Data Ethics and Privacy Lab

3. Advanced Internet of Things

Semester	Course Code	Course Name
VI	EC56T	Embedded Linux System
VI	EC56P	Embedded Linux System Lab
VII	EC60T	IOT & Data Analytics

VII	EC60P	IOT & Data Analytics Lab
VIII	EC64T	IOT Applications & Web Development
VIII	EC64P	IOT Applications & Web Development Lab

Courses to be successfully completed as a part of Minor Degree Programme

1. UI/UX

Semester	Course Code	Course Name
VI	IT67T	Foundations of UI/UX
VI	IT67T	Foundations of UI/UX Lab
VII	IT68T	UX Design, Evaluation & ARVR
VII	IT68T	UX Design, Evaluation & ARVR Lab
VIII	IT69T	USECASE in UI/UX
VIII	IT69T	USECASE in UI/UX Lab

2. Blockchain

Semester	Course Code	Course Name
VI	IT70T	Blockchain Technology
VI	IT70T	Blockchain Technology Lab
VII	IT71T	Smart Contract & Crypto Currencies
VII	IT71T	Smart Contract & Crypto Currencies Lab
VIII	IT72T	Decentralize & Blockchain Technologies
VIII	IT72T	Decentralize & Blockchain Technologies Lab

Detailed Syllabus of Honours – Sem VI

Course Name: Ethics in AIML

Course Code: EC54T

Category: Honours (Advance AIML)

Preamble:

The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has revolutionized numerous industries and daily life, introducing unprecedented opportunities and challenges. As these technologies integrate deeply into societal structures, it becomes imperative to consider their ethical, social, and environmental implications. This course aims to provide learners with a foundational understanding of ethical principles and frameworks as applied to AI/ML systems.

Pre-requisites:

Artificial Intelligence, Machine Learning

Course Objectives:

1. Understand ethical considerations in AI and ML development and deployment.
2. Explore frameworks for ethical decision-making in AI systems.
3. Assess potential biases, privacy issues, and impacts of AI on society.
4. Learn legal and policy implications related to AI and ML.
5. Develop skills to implement ethical practices in AI projects.
6. Foster critical thinking to address ethical challenges in real-world scenarios.

Course Outcomes:

Learner will be able to:

CO1: Demonstrate understanding of ethical principles in AI/ML.
CO2: Identify and mitigate bias and fairness issues in datasets and algorithms.
CO3: Apply ethical frameworks to evaluate AI systems.
CO4: Design AI systems with accountability, transparency, and fairness.
CO5: Understand societal impacts
CO6: Engage in ethical decision-making during AI system development.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Ethics in AI/ML	Overview of Ethics: Moral principles, ethics vs. legality. Why Ethics in AI/ML? Risks and challenges. Key Ethical Issues in AI: Bias, fairness, accountability, transparency. Case Studies: Real-world AI ethical dilemmas.	5
2	Bias and Fairness in AI/ML	Definition and Types of Bias in AI: Dataset bias, algorithmic bias. Techniques to Detect and Mitigate Bias in ML Models. Fairness Frameworks: Disparate impact, equalized odds. Ethical Data Collection and Preprocessing.	5
3	Privacy and Security Concerns	Privacy Challenges in AI: Data collection, storage, and sharing. Ethical Guidelines for User Data Protection. Security Risks in AI Systems: Deepfakes, adversarial attacks. GDPR and Other Privacy Regulations.	5
4	Accountability and Transparency	Need for Explainable AI (XAI). Strategies for Creating Transparent AI Systems. Accountability in AI Decision-Making. Ethical Implications of Autonomous Systems.	5
5	Societal Impacts of AI/ML	Impacts on Employment and Workforce. AI and Social Inequality. Misinformation and AI-Generated Content. AI in Healthcare, Education, and Governance.	5
6	Legal and Ethical Frameworks in AI	Overview of AI Ethics Guidelines (IEEE, UNESCO, etc.). AI Laws and Policies: International and regional perspectives. Intellectual Property and AI-Generated Content. Future Directions in AI Ethics.	5
Total			**30**

Textbooks:

1. AI Ethics: A Textbook by Paula Boddington - A comprehensive introduction to ethical challenges in AI systems.
2. Atlas of AI by Kate Crawford - Discusses the societal and environmental impact of AI

Reference Books:

1. The Ethical Algorithm by Aaron Roth & Michael Kearns - Explores designing socially aware algorithms
2. Human Compatible by Stuart Russell - Focuses on aligning AI with human values
3. Moral Machines: Teaching Robots Right From Wrong by Wendell Wallach and Colin Allen - Examines embedding ethics into AI systems.

Online Resources for Learning:

1. **Responsible AI Toolkit Reading List** - A curated set of academic papers and books focusing on responsible AI development and ethics Responsible AI Toolkit
2. **Oxford Academic Journals** - Offers edited volumes on AI ethics and related fields, often authored by leading experts

Course Name: Ethics in AIML Lab

Course Code: EC54P

Category: Honours (Advance AIML)

Preamble:

The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has revolutionized numerous industries and daily life, introducing unprecedented opportunities and challenges. As these technologies integrate deeply into societal structures, it becomes imperative to consider their ethical, social, and environmental implications. This lab manual is designed to equip learners with practical skills to address ethical concerns in AI and ML systems while fostering a deeper understanding of fairness, accountability, transparency, and privacy. Through guided experiments and critical discussions, students will explore the balance between technological innovation and ethical responsibility, preparing them to design and deploy AI systems that respect human values and promote societal good.

Pre-requisites:

Artificial Intelligence, Machine Learning

Lab Objectives:

1. Understand ethical considerations in AI and ML development and deployment.
2. Explore frameworks for ethical decision-making in AI systems.
3. Assess potential biases, privacy issues, and impacts of AI on society.
4. Learn legal and policy implications related to AI and ML.
5. Develop skills to implement ethical practices in AI projects.
6. Foster critical thinking to address ethical challenges in real-world scenarios.

Lab Outcomes:

Learner will be able to:
CO1: Demonstrate understanding of ethical principles in AI/ML.
CO2: Identify and mitigate bias and fairness issues in datasets and algorithms.
CO3: Apply ethical frameworks to evaluate AI systems.
CO4: Design AI systems with accountability, transparency, and fairness.
CO5: Understand societal impacts
CO6: Engage in ethical decision-making during AI system development.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	1	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by

a panel constituted at institute level and published to the learners before the commencement of the semester.

List of Experiments

1. Bias Detection and Mitigation in ML Models
2. Privacy Preservation Using Differential Privacy
3. Explainable AI (XAI): Interpreting Black-Box Models
4. Adversarial Attack and Defense Strategies
5. Fairness in AI-Powered Recommendation Systems
6. Simulating Ethical Dilemmas in Autonomous Systems
7. Energy Efficiency Analysis of ML Models
8. Ethical Concerns in NLP Models for Sentiment Analysis
9. Misinformation Detection Using AI
10. Guidelines for Ethical Data Collection and Labeling

Course Name: Data visualization using R Programming

Course Code: EC55T

Category: Honours (Advance Data Analytics)

Preamble:

It introduces fundamental concepts, advanced techniques, and best practices while introducing tools and libraries within the R ecosystem. It will train learners to interpret, design, and communicate insights effectively with real-world applications that bring into closer view the role of data visualization in decision-making.

Pre-requisites:

Skill Based Lab-Python Programming

Course Objectives:

1. Develop a good understanding of the theoretical underpinnings of data visualization, including principles of clarity, accuracy, and storytelling.
2. Learn how to use R programming and its visualization libraries such as ggplot2, plotly, and sf to create a range of charts and graphs.
3. Learn to clean, manipulate, and prepare data effectively for visualization using R's data wrangling packages like dplyr and tidyr.
4. Explore advanced visualization techniques, including geospatial mapping, interactive dashboards, and visualizations for complex datasets such as networks and time series.
5. Understand how to design and present visualizations that clearly communicate insights, supported by reproducible reports and presentations using R Markdown.
6. Demonstrate the ability to apply data visualization methods to real-world problems from a variety of domains, including business, healthcare, and environmental studies, through case studies and projects.

Course Outcome

Learner will be able to:
CO1: Understand and apply data visualization principles to enhance decision-making and avoid common pitfalls.
CO2: Demonstrates competence in using R and key libraries for visualization (ggplot2, dplyr, plotly) for data analysis.
CO3: Create and customize appropriate visualizations, such as scatter plots, bar charts, and histograms.
CO4: Prepare and maintain data for visualization through transformation and tidy data principles.
CO5: Improve advanced visualizations for multivariate, time series, and geospatial data, both statically and interactively.
CO6: Design accessible, effective visualizations using strong communication and aesthetic principles for diverse audiences.

Course Scheme:

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

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**

Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Data Visualization and R Basics	Importance of Data Visualization: Role in data analysis and decision-making, Definition and importance of data visualization in analytics and decision-making, Principles of effective visualization (clarity, simplicity, and accuracy), how to avoid misleading visualizations, Differences between exploratory and explanatory data visualization. Components: data, visual encodings, and context, Understanding visual perception and cognitive load. Introduction to R Programming: Overview of R and RStudio, Key libraries for visualization: ggplot2, dplyr, plotly Understanding Data Structures in R: Vectors, data frames, tibbles, and lists, Loading and exploring datasets in R	5
2	Fundamentals of Data Visualization	Types of Data and Their Visualization Needs: Categorical, numerical, temporal, and geospatial data, Matching chart types to data types. Overview of Chart Types; Scatter plots, bar charts, and line charts, Histograms, density plots, boxplots, and pie charts The Grammar of Graphics (ggplot2): Understanding layers: data, aesthetics, and geometries, Customizing plots with themes, labels, and legends. Understanding data mappings and coordinates Best Practices for Chart Selection: Choosing appropriate charts for categorical, numerical, and temporal data.	5
3	Data Preparation for Visualization	Data transformation: filtering, aggregating, and reshaping. Tidy Data Principles: Importance of structured data for visualization, Using tidyr and dplyr for data preparation. Handling Large Datasets: Sampling techniques and data summarization. Efficient visualization strategies for big data	5
4	Advanced Visualization Techniques	Visualization of Multivariate Data: Techniques for high-dimensional data (e.g., scatterplot matrices, parallel coordinates), Visualizing clustering and classification results. Multi-Panel Visualizations: Faceting techniques for subset comparison, Overlaying plots and combining visualizations Time Series Visualizations: Trend lines and seasonal patterns, Temporal patterns and trends, Smoothing and seasonal decomposition Geospatial Visualizations: Mapping spatial data and geospatial patterns, Incorporating layers, heatmaps, and choropleth maps, maps with ggplots and sf	5

5	Design Principles and Aesthetic Customization	Designing Visualizations for Communication: Structuring narratives for data-driven presentations, Color Theory and Accessibility: Effective use of color in data visualization, Ensuring accessibility (e.g., colorblind-friendly palettes), Customizing Visualization Elements: Titles, labels, legends, and annotations for clarity, Layout and spacing for better readability.	
6	Interactive and Specialized Visualizations	Interactive Visualization Concepts: The need for interactivity in data exploration, Overview of tools for creating interactive visualizations Specialized Visualization Types: Network visualizations (e.g., node-link diagrams), Statistical visualizations: regression plots, confidence intervals, and distributions, Representing regression results and confidence intervals, Diagnostic plots and residual analysis Tree maps and hierarchical data visualizations, Visualization for Big Data, Techniques for summarizing and aggregating large datasets, Sampling and visual encoding strategies	5
Total			**30**

Textbooks:

1. R for Data Science by Hadley Wickham and Garrett Grolemund
2. Data Visualization: A Practical Introduction by Kieran Healy

Reference books:

1. Practical Data Science with R by Nina Zumel and John Mount

Course Name: Data visualization using R Programming Lab

Course Code: EC55P

Category: Honor Degree Program (Advanced Data Analytics)

Preamble:

The Data & Feature Engineering Lab provides hands-on experience in applying data preprocessing and feature engineering techniques to real-world datasets. Students will learn to collect, clean, preprocess, and transform data to prepare it for analysis and modeling. In the feature engineering process, you start with your raw data and use your own domain knowledge to create features that will make your machine learning algorithms work. In this module we explore what makes a good feature. Through practical exercises and projects, students will develop proficiency in using tools and libraries commonly employed in data engineering tasks.

Prerequisites:

Skill Based Lab-Python Programming

Course Objectives:

1. Master R programming and manipulate various data structures effectively.
2. Perform exploratory data analysis (EDA) and analyze data patterns.
3. Match appropriate visualizations to different data types for meaningful insights.
4. Create and customize visualizations using the grammar of graphics (ggplot2).
5. Transform and prepare data for visualization using dplyr and tidyr.
6. Visualize high-dimensional and geospatial data and communicate insights clearly.

Course Outcomes:

Learner will be able to:
CO1: Apply R and RStudio tools to manipulate and explore data structures.
CO2: Perform basic exploratory data analysis and find insights in the data.
CO3: Select and apply the appropriate visualizations for categorical and numerical data.
CO4: Create and customize visualizations using ggplot2 and the grammar of graphics.
CO5: Transform and aggregate data for visualization using dplyr and tidyr.
CO6: Visualize high-dimensional and geospatial data and effectively communicate insights.

Course Scheme:

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

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

Suggested list of experiments:

Sr. No.	List of experiments
1	Introduction to R and RStudio
2	Create, access, and modify various data structures in R
3	Loading and Exploring Datasets and perform basic exploratory data analysis (EDA).
4	Visualizing Categorical and Numerical Data and Match the right chart type to different data types
5	Understand the grammar of graphics and create plots like scatter plots, line charts, and box plots using ggplot2
6	Data transformation techniques for data visualization (filtering, aggregating, reshaping).Using dplyr and tidyr to filter and aggregate a dataset
7	Implement data sampling techniques, perform summarization
8	Visualize high-dimensional data using techniques like scatterplot matrices and parallel coordinates.
9	Visualize geospatial data using ggplot2 and sf using choropleth maps
10	Design effective visualizations for storytelling and communication.

Textbooks:

1. R for Data Science by Hadley Wickham and Garrett Grolemund
2. Data Visualization: A Practical Introduction by Kieran Healy

Reference books:

1. Practical Data Science with R by Nina Zumel and John Mount

Course Name: Embedded Linux System

Course Code: EC56T

Category: Honours (Advance IOT)

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.

Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Student will be able to:

CO1: Understand fundamental concepts of operating System.
CO2: Understand architecture of Linux operating system for embedded system applications.
CO3: Understand concept of kernel.
CO4: Use Linux kernel module.
CO5: Do communication between user space and kernel space.
CO6: Develop applications.

Course Scheme:

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

Assessment Guidelines:

Head	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	RTOS and Linux based Embedded Systems: An Introduction	Introduction to Real Time Operating Systems: Characteristics of RTOS, Tasks Specifications and types, Real-Time Scheduling Algorithms, Concurrency, Inter-process Communication and Synchronization mechanisms, Priority Inversion, Inheritance and Ceiling. Operating systems for embedded systems, Why Linux-based embedded systems? Linux evolution Embedded Linux Vs Desktop Linux, Embedded Linux Distributions, System calls, Static and dynamic libraries, Cross tool chains. Linux-based embedded system: example	05
2	Embedded Linux Architecture and Kernel Architecture	Architecture of Embedded Linux- Real Time Executive, Monolithic kernels, Microkernel. Linux Kernel Architecture- Hardware Abstraction Layer (HAL), Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC. User space, Linux Start-up sequence.	05
3	Building and Debugging	Building the Kernel, Building Applications, Building the Root File System, Integrated Development Environment, Debugging Virtual Memory Problems, Kernel Debuggers, Profiling	05
4	Introduction to Linux kernel modules	Introduction, CPU – I/O interface, I/O interface with polling, I/O interface with interrupt, I/O interface, I/O interface latency, Direct memory access (DMA) architecture - transfer modes, I/O taxonomy, Typical operations, Linux devices, The Virtual File System (VFS) abstraction. Linux kernel modules – the initialization function, the cdev data structure, the initialization function, the clean-up function, custom VFS functions.	06
5	Communication Between Kernel and User Space	Introduction, The reference use case, The CPU/Device interface, The module level – file operations, ioctl() implementation, open()/release() implementation, read() implementation, Passing data to/from the kernel, write() implementation, communication with the device, Memory mapped I/O – initialization, clean-up, read, write, GPIO-based I/O – initialization, clean-up, read, write, Interrupts, Requesting the interrupt line, Freeing the interrupt line, The interrupt handler, Interrupt handling, Top-half and bottom-half, Needed support, Work queue, The user level, The user level – the application	06
6	Porting Applications	Architectural Comparison, Application Porting Roadmap, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver.	03
Total			**30**

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Assessment:

1. **ISA (In-Semester-Assessment):** In semester assessment will carry total 15 marks. It will consist of weekly graded assignments based on modules (each carrying 10 marks). The assignments are self-study work and need to be completed by individual students separately. Every student will be submitting four completed assignments. Students are encouraged to develop their own problem solution and devise a proper method/technique. Importance will be given to the concept understanding and applying it to solve the industrial problem using coding.

2. **MSA (Mid-Semester-Assessment):** Mid Semester Assessment will consist of three mid semester internal theory test carrying 20 marks based on completion of minimum modules. This test will be common for all the students. ***Repeat examination will not be conducted.***

3. **ESE (End-Semester-Examination):** End Semester Examination will be conducted for total of 40 marks based on the completion of remaining modules post completion of mid semester examination or an entire syllabus. This test will be common for all the students.

Course Name: Embedded Linux System Lab

Course Code: EC56P

Category: Honours (Advance IOT)

Preamble:

The rapid growth of Linux as an embedded operating system in many products is due to the ease of using embedded Linux to replace home-grown operating systems. Linux-based embedded systems are widely used in smartphones, in-vehicle infotainment systems, in countless consumer electronics and for numerous industrial applications. It may be the need for TCP/IP networking, USB support, Secure Digital support, or some other standard that causes a company to dump their current operating system and switch to Linux. But it is the joy of developing with Linux that keeps the engineers promoting it for future products. The objective of the course is to give students solid introductory knowledge on Linux OS and internals of Linux for embedded system design.

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Pre-requisites:

- C Programming
- Object Oriented Programming
- Microprocessor and microcontroller

Course Objectives:

- To understand role of operating system in embedded system development.
- To understand architecture of operating systems for embedded system applications.
- To understand different types of kernels.
- To understand kernel module of Linux.
- To understand communication between user and operating system.
- Use Linux operating system in embedded system application.

Course Outcomes:

Student will be able to:

CO1: Demonstrate fundamental concepts of operating System.
CO2: Demonstrate architecture of Linux operating system for embedded system applications.
CO3: Demonstrate concept of kernel.
CO4: Use Linux kernel module with standard commands.
CO5: Establish communication from user space to kernel space.
CO6: Develop embedded system applications based on Linux operating system.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSE	ESE	Total
Practical	25	-	25	25

Suggested List of Practical:

1. Introduction to the Board and Workspace Set-Up.
2. Custom Embedded Linux Build Using the Manual Approach.
3. Introduction to Linux Kernel Modules under Yocto.
4. Handling General Purpose I/O Using Linux Kernel Modules.
5. Handling Hc-Sr04 Ranging Sensor Using Linux Kernel Modules.
6. Introduction to Code Development and Debugging Using Yocto.
7. Introduction to Linux Kernel and Application Profiling.
8. Installing Linux kernel and configuration of Rasp-berry Pi computer (SBC)
9. Installation of Free RTOS and integration with Keil IDE for multithreaded application.

Practical can be designed using project-based approach.

Textbooks:

1. "Embedded Linux System Design and Development", P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications.
2. "Mastering Embedded Linux Programming", Chris Simmonds Second Edition, PACKT Publications Limited.
3. "Embedded Linux Primer: A Practical Real World Approach", Christopher Hallinan, Prentice Hall, 2nd Edition, 2010

Reference Books:

1. "Building Imbedded Linux Systems", Karim Yaghmour, O'Reilly & Associates.
2. Embedded Linux Systems with the Yocto Project, Rudolf K. Sterif

Assessment: In-Semester-Assessment (25 Marks)

1. ***All the students are required (mandatory) to be present in person during the laboratory conduction session.*** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. ***Project prototype to be developed and demonstrated.***
3. ***Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.***
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work, developing code / solution to the given problem and peer interaction. ***Student will lose the marks if he or she remains absent for the Laboratory Practical Session.***

Detailed Syllabus of Minor – Sem VI

Course Name: Foundations of UI and UX

Course Code: IT67T

Category: Minor (UI/UX)

Preamble:

Usability engineering is a framework for evaluating digital products or services that focuses on the optimization of usability. It incorporates theories from both psychology and computer science. It involves an iterative approach to design by considering the needs, abilities, or even limitations of the intended users. UX designers focus on the interactions that people have with products like websites, mobile apps, and physical objects. UX designers make those everyday interactions usable.

Pre-requisites: Nil

Course Objectives:

1. To stress the importance of User Interface and User Experience.
2. To Learn User, Experience Process.
3. To understand how to design Effective and Efficient User Interfaces for intended users.
4. To Learn user research techniques
5. To create personas
6. To understand UX guidelines

Course Outcomes:

CO1: Understand the importance of user interface and User Experience.
CO2: Learn user experience process
CO3: Understand how to design Effective and Efficient User Interfaces for intended users.
CO4: Learn user research techniques.
CO5: Create personas.
CO6: Understand UX guidelines.

Course Scheme:

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

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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:

Sr. No.	Module	Detailed Content	Hrs
0	Prerequisite	Web Technologies, Software Engineering Process	03
1	Introduction	What is UX, Ubiquitous interaction, Emerging desire for usability, From usability to user experience, Emotional impact as part of the user experience, User experience needs a business case, Roots of usability.	04
2	The Wheel: A Lifecycle Template	Introduction, A UX process lifecycle template, Choosing a process instance for your project, The system complexity space, Meet the user interface team, Scope of UX presence within the team, More about UX lifecycles.	04
3	Contextual Inquiry: Eliciting Work Activity Data	Introduction, User research , User work activity gathering, Look for emotional aspects of work practice, Abridged contextual inquiry process, Data-driven vs. model-driven inquiry, History. ,Contextual Analysis, Extracting Interaction Design Requirements, Constructing Design-Information Models.	06
4	Design Thinking, Ideation, and Sketching,	Introduction, Design paradigms, Design thinking, Design perspectives, User personas, Ideation, Sketching, More about phenomenology, Mental Models and Conceptual Design, Wireframe, Prototyping	06
5	Wireframes and Prototyping	Introduction to wireframes, types of woreframes, prototyping , types of prototyping	06
6	UX Design Guidelines	Introduction, Using and interpreting design guidelines, Human memory limitations, Selected UX design guidelines and examples, Planning, Translation, Physical actions, Outcomes, Assessment, Overall.	04
		Total	**30**

Online resources

https://nptel.ac.in/courses/107/103/107103083/

https://www.uxbeginner.com/ux-courses/

Course Name: Foundations of UI and UX Lab

Course Code: IT67P

Category: Minor (UI/UX)

Preamble:

Usability engineering is a framework for evaluating digital products or services that focuses on the optimization of usability. It incorporates theories from both psychology and computer science. It involves an iterative approach to design by considering the needs, abilities, or even limitations of the intended users. UX designers focus on the interactions that people have with products like websites, mobile apps, and physical objects. UX designers make those everyday interactions usable.

Pre-requisites: Nil

Course Objectives:

1. To stress the importance of User Interface and User Experience.
2. To Learn User Experience Process.
3. To understand how to design Effective and Efficient User Interfaces for intended users.
4. To Learn user research techniques
5. To create personas
6. To understand UX guidelines

Course Outcomes:

CO1: Understand the importance of user interface and User Experience.
CO2: Learn user experience process
CO3: Understand how to design Effective and Efficient User Interfaces for intended users.
CO4: Learn user research techniques.
CO5: Create personas.
CO6: Understand UX guidelines.

Course Scheme:

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

Assessment guidelines:

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

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested Experiments

- Perform user research
- User requirement collection
- User Requirement Analysis
- Create User personas, user scenarios , customer journey maps etc
- Create Wireframes
- Create Prototypes
- Set UX Goals
- Any two case studies or mini project covering the above syllabus

Textbooks:

1. The UX Book by Rex Hartson and Pardha Pyla
2. Smashing UX Design by Jesmond Allen and James Chudley
3. Lean UX: Applying Lean Principles to Improve User Experience by Jeff Gothelf and Josh Seiden
4. Don't Make Me Think, Revisited by Steve Krug
5. The User Experience Team of One by Leah Buley
6. The Elements of User Experience by Jesse James Garrett
7. Sketching User Experiences: The Workbook by Saul Greenberg, Sheelagh Carpendale, Nicolai Marquardt and Bill Buxton

Reference Books:

1. A Project Guide to UX Design by Russ Unger and Carolyn Chandler
2. Agile Experience Design by Lindsay Ratcliffe and Marc McNeill
3. Universal Principles of Design by William Lidwell, Kritina Holden and Jill Butler
4. Human Computer Interaction by Alan Dix

Course Name: Blockchain

Course Code: IT70T

Category: Minor (Blockchain)

Preamble:

Blockchain Technology course provides students with a comprehensive understanding of blockchain fundamentals, decentralized systems, and their applications. Through lectures, case studies, and hands-on exercises, students will learn about the underlying principles of blockchain technology, its evolution, and its potential impact on various industries. Topics covered include distributed ledger technology, consensus mechanisms, smart contracts, cryptocurrencies, and real-world use cases.

Pre-requisites:
Computer Network

Course Objectives:
1. To understand conceptual elements for Blockchain Technologies.
2. To summarize the major developments related to Blockchain and crypto currencies.
3. To identify Real-world applications of block chain.

Course Outcomes:
Learner will be able to:
CO1: Identify the importance of Blockchain technology
CO2: Interpret the fundamentals and basic concepts in Blockchain
CO3: Summarize the requirements of the basic design of blockchain.
CO4: Compare the working of different blockchain platforms
CO5: Summarize the different technologies and latest trends in Blockchain
CO6: Analyze the importance of blockchain in finding the solution to the real-world problems.

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised 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 Blockchain Technology	Basic ideas behind block chain, how it is changing the landscape of digitalization, introduction to cryptographic concepts, Hashing, public key cryptosystems, private vs public block chain and use cases, Hash Puzzles.	5
2	Blockchain Fundamentals	Basic architecture of Blockchain, different terminologies associated, Characteristics of Block chain, Types of networks, Introducing Smart contract concept in Blockchain.	5
3	Components of Blockchain	Core components of Blockchain, Types of Block chains; Blockchain Protocol, Permission & Permission less Block chains.	5
4	Digital Ledger	Short History of Money and Trust, Bitcoin Mechanics, Introduction to Ethereum, Introduction to Hyperledger, Hyperledger Fabric and its architecture, Hyperledger Composer	5
5	Emerging Trends in Blockchain:	Cloud-based block chain, Multi chain, Geth , Stellar , Ripple, R3 Corda, Blockchain API, Blockchain Sandboxes	5
6	Block Chain Use Cases	Supply Chain Management, Finance, Health Care, Internet of Things (IoT), Remittance, Land Records, Voting and election, Loyalty Programs, Go Green (Renewable Energy).	5
Total			**30**

Textbooks:

1. Artemis Caro, "Blockchain: The Beginners Guide to Understanding the Technology Behind
   a. Bitcoin & Crypto currency".
2. Scott Marks, "Blockchain for Beginners: Guide to Understanding the Foundation and Basics of
   a. the Revolutionary Blockchain Technology", Create Space Independent Publishing Platform

Reference Books:

1 Mark Watney, "Blockchain for Beginners".
2. Alwyn Bishop, "Blockchain Technology Explained".

E-sources:

1. NPTEL Course **"Introduction to Blockchain Technology & Applications"**
https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on **"Blockchain Architecture &UseCases"**
https://nptel.ac.in/courses/106/105/106105184/

Course Name: Blockchain Lab

Course Code: IT70P

Category: Minor (Blockchain)

Preamble:

Blockchain Technology course provides students with a comprehensive understanding of blockchain fundamentals, decentralized systems, and their applications. Through lectures, case studies, and hands-on exercises, students will learn about the underlying principles of blockchain technology, its evolution, and its potential impact on various industries. Topics covered include distributed ledger technology, consensus mechanisms, smart contracts, cryptocurrencies, and real-world use cases.

Pre-requisites:
Computer Network

Course Objectives: After completion of the course, students will have adequate background, conceptual clarity and knowledge related to:
1. The working of blockchain technology
2. The real-world applications of Blockchain.

Course Outcomes:
Students who complete this course successfully are expected to:

CO 1. Understand working of Blockchain.

CO 2. Creating Cryptographic hash using Merkle tree.

CO 3. Understand data protection using Blockchain.

CO 4. Understand the cryptographic basis for cryptocurrency.

CO 5. Creating genesis block using open-source tool.

CO6. Choose a blockchain implementation based on real time scenario

Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

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

Suggested list of experiments:

Sr. No.	List of experiments
1	Case Study on various Blockchain platforms.
2	Cryptography in Blockchain, Merkle root tree has
3	Two Factor Authentication using blockchain
4	Blockchain based application Crypto Exchange and Wallet.
5	Create the genesis block using Puppeth, a CLI tool.
6	Implement simple Smart Contracts in Remix IDE

Textbooks:

1. The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects by by Elad Elrom.
2. Practical Blockchains and Cryptocurrencies by Karan Singh Garewal