Shree Rahul Education Society's (Regd.)

SHREE L. R. TIWARI COLLEGE OF ENGINEERING

An Autonomous Institute Affiliated to University of Mumbai,

Approved by AICTE & DTE, Maharashtra State | NAAC Accredited, NBA Accredited Program | ISO 9001:2015 Certified |
DTE Code No: 3423 | Recognized under Section 2(f) of the UGC Act 1956 | Minority Status (Hindi Linguistic)

Shree Rahul Education Society's (Regd.)

Shree L.R. Tiwari College of Engineering

Shree L.R. Tiwari Educational Campus,

Mira Road–East, Thane-401107.

Maharashtra, India

www.slrtce.in

An Autonomous Institute Affiliated to the University of Mumbai

Department of Electronics &Telecommunication Engineering

Curriculum TY A.Y 2026-27

Third Year Syllabus

Revision: R-2025

PREAMBLE

"Think. Design. Innovate. – Learning that Leads the Future."

SLRTCE is proud to be among the youngest institutions to attain academic autonomy—an achievement that strengthens our commitment to becoming a world-class centre for socio- economic development and quality education. It is with great pride and purpose that we introduce the restructured curriculum under academic autonomy at SLRTCE. This initiative marks a significant step toward transforming engineering education by equipping our graduates with strong technical foundations, research acumen, interdisciplinary perspective, and an innovation-driven mindset essential for success in today's evolving professional landscape.

1. **Curriculum Design:** Theme-Based, Experiential, and Outcome-Oriented The autonomous curriculum adopts a bottom-up, learner-centric approach aligned with all 12 Program Outcomes. Each semester is driven by a central societal or technological theme, with problem statements rooted in local needs, socio-economic priorities, and the UN Sustainable Development Goals (UNSDGs). Students engage with these challenges through individual projects in the IDEA Lab, integrating social science methodologies with engineering solutions to foster innovation, contextual learning, and socially responsible problem-solving.

2**. Purpose of Autonomy:** Empowering Innovation and Real-World Learning Our pursuit of autonomy is rooted in bridging the gap between academic learning and industry relevance. By integrating undergraduate research through the IDEA Lab—our dedicated innovation and problem-solving hub—students engage with real-world challenges, apply interdisciplinary knowledge, and develop socially impactful solutions. This approach nurtures engineers who are not only technically sound but also responsible and creative thinkers.

3. **Alignment with National Education Policy-2020:** Aligned with NEP 2020, the curriculum emphasizes multidisciplinary, hands-on learning. Through theme-based projects, electives, value-added courses, and flexible assessments, SLRTCE ensures holistic student development driven by real-world application and academic rigor. SLRTCE, as a part of Rahul Education, benefits from being in a network of HEIs. All Higher Education Institutions under Rahul Education can collectively contribute to curriculum development, promoting multidisciplinary studies.

4. **Innovative Pedagogy Initiative by IQAC As part of its transformation strategy**, IQAC has introduced an innovative pedagogy model centred on interdisciplinary research and contextual problem-solving. The IDEA Lab enables students to apply subject knowledge through socially relevant projects, supported by design thinking and faculty mentorship. A two-tier assessment framework—covering both project execution and subject-wise application—ensures academic depth, continuous mentoring, and quality assurance.

5. **Empowering Faculty as Mentors and** Innovators: SLRTCE believes that the success of academic autonomy lies in the hands of its faculty. By empowering educators to think beyond conventional boundaries, we enable them to instil Knowledge, Skills, and Attitudes (KSA) in students while enriching their own professional growth. Faculty serve as research mentors and project guides, supported through structured training in innovation pedagogy and assessment**.**

Sincerely,

IQAC Chairperson
SLRTCE

COO
Rahul Education

PREFACE (BOS)

The Electronics and Telecommunication Engineering (EXTC) program at our autonomous institute under Mumbai University is a dynamic and future-ready course that blends the principles of electronic systems with cutting-edge communication technologies. Designed to empower students with deep technical knowledge and interdisciplinary skills, the program enables innovation across domains such as wireless communication, signal processing, embedded systems, networking, and next-generation communication protocols.

Leveraging our autonomous status, the curriculum is continuously updated to stay at the forefront of technological advancements and evolving industry needs. Key focus areas include 5G and beyond, Internet of Things (IoT), satellite and optical communication, AI-driven networks, and cyber-physical systems — ensuring that students are well-prepared for careers in both core industries and emerging tech sectors.

A distinctive component of the program is the emphasis on experiential learning through labs, design studios, and interdisciplinary project platforms such as the **IDEA** Lab. This environment fosters creativity, systems thinking, and collaborative problem-solving, allowing students to translate theory into impactful real-world applications.

The EXTC program also embraces a strong commitment to societal relevance and ethical responsibility. Students are encouraged to develop inclusive and sustainable communication solutions aligned with the United Nations Sustainable Development Goals (UN SDGs). Whether it's improving health outcomes through telemedicine (SDG 3), supporting quality education via digital connectivity (SDG 4), enhancing urban resilience with smart infrastructure (SDG 11), or enabling disaster response through resilient communication networks (SDG 13), our students are challenged to innovate with purpose.

Combining rigorous academic training with practical insights, a global perspective, and a strong ethical foundation, the EXTC program cultivates technically proficient, socially conscious engineers ready to lead in a world increasingly defined by intelligent and connected systems.

Mrs.Swapna Patil

EXTC-HOD

BOS Chairman

Abbreviations

AEC	Ability Enhancement Course
AECL	Ability Enhancement Course Laboratory
AU	Audit Course
BSC	Basic Science Course
BSCL	Basic Science Course Laboratory
CC	Co-Curricular Courses
CEP	Community Engagement Project
ELC	Experiential Learning Course
ESC	Engineering Science Course
ESCL	Engineering Science Course Laboratory
EMC	Entrepreneurship/economics/management courses
HSSM	Humanities Social Sciences and Management
IKS	Indian Knowledge System
INTR	Internship
L	Lecture
LC	Laboratory Course
LLC	Liberal Learning Course
MDM	Multidisciplinary Minor
MDML	Multidisciplinary Minor Laboratory
OE	Open Elective
OJT	On Job Training
P	Practical
PROJ	Project
PCC	Program Core Course
PCCL	Program Core Course Lab
PEC	Program Elective Course
RM	Research Methodology
SL	Self-Learning
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course

Curriculum Structure and Examination Scheme for B.Tech. in Electronics and Telecommunication Engineering
(TY with Effect from AY 2026-2027) Curriculum Structure – TY Semester-V

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)	Examination Scheme				Exam Duration for Theory (in Hrs.)	Term Work	Practical / Oral	Total
												In-Semester Assessment			End Semester Exam (ESE)				
			L	T	P	L	T	P	SL	Notional Learning		IAT-I	IAT-II	Total					
14211501	PCC	Computer communication Network	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
14211502	PCC	Discrete Time Signal Processing	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
14211503	PCC	Digital VLSI	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
14212504	PCC LAB	Computer Communication Network Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
14212505	PCC LAB	Discrete Time Signal Processing Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
14212506	PCC LAB	IDEA LAB -5	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
1422157 XX	PEC-I	Elective Bucket	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
99311508 WW	MDM-II	MDM Bucket	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	--	--	100
14412509	VSEC	Skill lab Linux and Networking	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	--	25
99512510 XX	OE-III*	OE Bucket	2	--	--	30	--	--	30	60	2	--	--	--	--	--	25	--	25
Total			**17**	**–**	**8**	**285**	**–**	**90**	**285**	**630**	**21**	**100**	**100**	**200**	**300**	**12.5**	**125**	**2.5**	**700**

Program Elective Course-I	
Course Code	**Name of the Course**
142215701	Cloud Computing
142215702	Data Compression and Cryptography
142215703	Data Structure and Algorithm
142215704	Sensor Technology

Open Elective-III*	
Course Code	**Name of the Course**
9951251001	Corporate Finance
9951251002	Economics of Banking and Finance Markets
9951251003	HR Analytics
9951251004	International Financial Management
9951251005	Marketing Management - I
9951251006	Operations and Supply Chain Management
9951251007	Principles of Behavioral Economics
9951251008	Quantitative Investment Management

Students who achieve a CGPI of 7.5 or higher by the end of the semester VI are eligible to pursue an additional 18 credits from the semesters V to VIII to qualify for a B. Tech degree with Honors.

Curriculum Structure and Examination Scheme for B.Tech. in Electronics and Telecommunication Engineering (TY with Effect from AY 2026-2027) Curriculum Structure – TY Semester-VI

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)	Examination Scheme				Exam Duration for Theory (in Hrs.)	Term Work	Practical / Oral	Total
												In-Semester Assessment			End Semester Exam (ESE)				
			L	T	P	L	T	P	SL	Notional Learning		IAT-I	IAT-II	Total					
14211601	PCC	Electromagnetics and Antenna	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
14211602	PCC	Artificial Intelligence and Machine Learning	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
14211603	PCC	Image Processing and Applications	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
14212604	PCC LAB	Electromagnetics and Antenna Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
14212605	PCC LAB	Image Processing and Applications Lab	--	--	2	--	--	30	--	30	1	--	--	--	--	--	25	25	50
14812606	PROJECT	Dissertation -1	--	--	2	--	--	30	--	30	1	--	--	--	--	--	50	50	100
1422167 XX	PEC-II	Elective Bucket	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
9931168 WW	MDM-III	MDM Bucket	3	--	--	45	--	--	45	90	3	20	20	40	60	2.5	–	–	100
98412609	VEC	Professional Communication and Ethics - II	2	--	--	30	--	--	30	60	2	–	–	–	–	–	25	–	25
99512610 XX	OE-IV*	OE Bucket	2	--	--	30	--	--	30	60	2	–	–	–	–	–	25	--	25
Total			**19**	**--**	**6**	**285**	**--**	**90**	**285**	**660**	**22**	**100**	**100**	**200**	**300**	**12.5**	**150**	**100**	**750**

Program Elective Course-II	
Course Code	**Name of the Course**
142216701	Computer Organisation and Architecture
142216702	Database Management System
142216703	IOT Industry 4.0
142216704	Mixed Signal VLSI

Open Elective-IV	
Course Code	**Name of the Course**
9951261001	Cultural Studies Language for Competitive Exams
9951261002	Direct foreign language courses (like German, French)
9951261003	Ethics in Engineering Practice
9951261004	Financial Institutions and Markets
9951261005	Introduction to Psychology
9951261006	Introduction to Sociology
9951261007	Investment Management
9951261008	Moral Thinking: Introduction to Values and Ethics

Note:

1. Questions based on self-learning must not be asked in internal assessment and End semester Exam

2. IDEA Lab: The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.

3. Notional Learning Hours: In higher education, Notional Learning Hours (NLH) indicates the estimated time that a typical learner, at a specific academic level, is expected to invest in order to achieve the set learning outcomes of a course or module. This time includes a range of structured and independent learning activities, each contributing to the development of knowledge and competencies within a module

4. Self-Learning (SL): Self-learning is integrated into both theory and practical subjects, particularly where practical sessions have only one contact hour per week. It emphasizes student-driven efforts in preparing for assignments, practicals, and examinations. Additionally, self-learning includes topics that go beyond the prescribed syllabus to align with current industry trends and requirements. Assessment of self-learning will follow a formative approach. For theory subjects that include term work, 30% of the assignment questions and student presentations/discussions should be based on self-learning topics. In subjects without term work, the corresponding laboratory sessions will incorporate self-learning, carrying a weightage of 30%. The subject with no term work and practical will have no assessment on self-learning topics. This may involve laboratory work using the latest tools or preparing technical write-ups/research papers on advanced topics.

SEM-V

Semester – V

Theme: Urban System

Aligned with UNSDG: SDG 9 – Industry, Innovation and Infrastructure, SDG 11 – Sustainable Cities and Communities, SDG 12 – Responsible Consumption and Production, SDG 16 – Peace, Justice and Strong Institutions.

Problem Statement 1:

To study challenges in urban systems and demonstrate a very basic system for improved service efficiency.

Problem Statement 2:

To observe urban resource usage and demonstrate a very basic system for better coordination.

Problem Statement 3:

To study urban service practices and demonstrate a very basic system supporting sustainability.

Problem Statement 4:

To observe operational patterns in urban environments and demonstrate a very basic system for improvement.

Problem Statement 5:

To study urban infrastructure needs and demonstrate a very basic system for better management.

Problem Statement 6:

To study mobility-related challenges in urban environments and explore approaches that improve movement and accessibility.

Problem Statement 7:

To investigate the interaction between urban services and citizens and identify opportunities for improved service delivery.

Problem Statement 8:

To observe public service usage and demonstrate a very basic system for efficient operation.

Problem Statement 9:

To study urban system behavior and demonstrate a very basic system supporting organized functioning.

Problem Statement 10:

To observe service-related challenges in urban areas and demonstrate a very basic system for enhancement.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211501	Computer Communication Networks	3	–	--	45	-	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211501	Computer Communication Networks	20	20	40	60	2.5	--	--	100

Rationale:

This course provides essential knowledge of computer communication networks, covering architectures, protocols, and security with an emphasis on sustainable and smart digital infrastructure. It equips students with practical skills through simulations and hands-on labs, fostering industry readiness for roles such as Network Engineer and System Administrator. The curriculum aligns with NEP 2020 and UNSDGs, promoting environmentally conscious and socially responsible network design.

Course Objectives:

1. To design and analyze modern computer communication networks for smart and sustainable environments.
2. To explore the TCP/IP architecture and compare it with OSI models using real-world applications.
3. To apply knowledge of networking principles in solving problems aligned with digital infrastructure and sustainability.
4. To simulate, evaluate, and secure network protocols with environmental and societal

awareness.

Course Outcomes:

1. Analyze various network architectures, protocols, and addressing schemes.
2. Compare broadband technologies and evaluate their environmental impact.
3. Apply flow control and error control methods in data link protocols.
4. Design routing strategies and implement efficient routing protocols.
5. Distinguish between transport layer services and construct error-free connections.
6. Demonstrate application layer protocols for real-world services like e-Governance

Prerequisite:

1. Principles of communication engineering
2. Digital communication

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Network Architectures, Protocol Layers, and Service models**	Applications of Computer Networks. Types of Networks: LAN, MAN, WAN. Network Topologies: Bus, Star, Ring, Mesh. Protocols and Standards; OSI vs TCP/IP. Network Hardware Devices.	08	CO1
		Self-Learning Topics: Evolution of network protocols, Software Defined Networking, Network Function Virtualization	08	
II	**Physical Layer**	Guided Media: Twisted pair, coaxial, optical fiber. Unguided Media: Radio, microwave, infrared. Transmission Impairments: Attenuation, noise, distortion. Broadband Access Technologies: Cable modem, DSL, HFC.	07	CO2
		Self-Learning Topics:	07	

		Smart grid communication media. Green networking and eco-friendly cable types.		
III	**Data Link Layer**	Data Link Services: Framing, Flow control, Error control. ARQ Methods: Stop-and-Wait, Go-Back-N, Selective Repeat. HDLC: Modes, frame types, bit stuffing. MAC Protocols: ALOHA, CSMA, CSMA/CD.	08	CO3
		Self-Learning Topics: Frame Relay vs HDLC, Emerging MAC protocols in 5G networks.	08	
IV	**Network Layer**	Circuit and Packet Switching. IPv4: Packet format, addressing. Routing Algorithms: RIP, OSPF, BGP, EIGRP. Address Management: Subnetting, VLSM, NAT. Support Protocols: ICMP, ARP, RARP. IPv6 and Transition Techniques. QoS Metrics and Mechanisms.	08	CO4
		Self-Learning Topics: Internet of Things (IoT) Addressing Challenges Routing in wireless sensor networks (WSN)	08	
V	**Transport Layer**	TCP: Services, segments, handshake. UDP: Features and datagram. Checksum Computation. Flow, Error, Congestion Control.	07	CO5
		Self-Learning Topics: TCP/IP performance over satellite networks Congestion control in real-time communication	07	
VI	**Application Layer**	HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP. Application scenarios: e-learning, governance, IoT.	07	CO6
		Self-Learning Topics:	07	

		Email spoofing and SMTP security, DNS over HTTPS (DoH), IoT and Application Layer Security		
	Total		90	

Text Books:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition, TMH, 2013.
2. Computer Networks – Andrew S. Tanenbaum, 5th Edition, Pearson Education, 2013.
3. Computer Networking: A Top-Down Approach – Kurose and Ross, 5th Edition, Addison Wesley, 2010.

References:

1. Data and Computer Communications – William Stallings, 10th Edition, Pearson.
2. An Engineering Approach to Computer Networks – S. Keshav, 2nd Edition, Pearson.
3. Understanding Communications and Networks – W. A. Shay, 3rd Edition, Cengage Learning.
4. Green Networking and Communications – Constantine Polychronopoulos, CRC Press.
5. UNESCO ICT Competency Framework for Teachers (ICT-CFT).

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/
2.	https://www.netacad.com/courses/packet-tracer
3.	https://developer.mozilla.org/en-US/docs/Web/HTTP

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks

2. No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211502	Discrete Time Signal Processing	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211502	Discrete Time Signal Processing	20	20	40	60	2.5	--	--	100

Rationale:

This course is designed to provide students with an in-depth understanding of digital signal processing (DSP) techniques and their applications. Emphasis is placed on the analysis and design of IIR and FIR filters, frequency transformations, FFT algorithms, and the impact of finite word-length effects in digital systems. Students will gain both theoretical insights and practical experience, enabling them to apply DSP techniques to real-world problems in biomedical, speech, and communication systems.

Course Objectives:

1. To develop a foundation in classification of signals and systems and operations of discrete-time signals
2. To introduce the fundamentals and mathematical foundations of the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms.

3. To design and analyze IIR digital filters using various transformation techniques from analog filters.
4. To develop FIR digital filters using windowing and frequency sampling techniques, and compare their characteristics with IIR filters.
5. To explore various digital filter structures and evaluate their computational complexity and realization methods and understand the effects of finite word length on digital filters.
6. To expose students to practical DSP applications in biomedical signal processing and speech enhancement.

Course Outcomes: After successful completion of the course student will be able to

1. Classify and analyze different types of signals and systems
2. Apply DFT and FFT techniques for spectral analysis and filtering of long data sequences.
3. Implement and analyze IIR digital filters using impulse invariant and bilinear transformation techniques.
4. Design FIR digital filters using windowing and frequency sampling methods.
5. Realize and compare various digital filter structures for efficient implementation and analyze the effect of finite word length on digital filters.
6. Apply DSP techniques for processing ECG, EEG, and speech signals in realworld applications

Prerequisite:

1. Mathematics for signal analysis

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to signals and systems**	**Introduction to Signals:** Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals **Systems and Classification of systems:** System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.	07	CO1

		Self-learning Topics: Time transformations, graphical analysis, convolution basics, impulse response, and real-life examples of signals and systems.	07	
II	**Discrete Fourier Transform & Fast Fourier Transform**	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method, Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	08	CO2
		Self-learning Topics: Spectral Leakage in DFT, Windowing Techniques in DFT Analysis, Bit Reversal in FFT, Introduction to composite FFT	08	
III	**IIR Digital filters**	LTI systems as frequency selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic. Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	08	CO3
		Self-learning Topics: Pole-zero analysis, pre-warping, filter approximation comparison, frequency warping, and sensitivity analysis of practical IIR filter design and implementation issues.	08	
		Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and		

IV	**FIR Digital Filters**	mixed phase systems. Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique –Type I low pass filter design, Comparison of IIR and FIR filters	07	CO4
		Self-learning Topics: Gibbs phenomenon, window size effects, simple MATLAB implementation, and applications of FIR filter design	07	
V	**Digital Filter Structures & Finite Word Length Effects**	Realization of Digital Filters: Structures for the realization of Discrete Time Systems: Block diagram and signal flow graph representations of filters. FIR Filter Structures: Linear Phase realization, Direct Form, Cascade Form. IIR Filter Structures: Direct Form, Cascade Form and Parallel Form. Finite word length effects in digital filters: Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling.	08	CO5
		Self-learning Topics: Polyphase structures, lattice filters, finite word length effects, and FFT-based fast convolution enhance understanding of efficient, stable, and practical implementations of digital filters beyond basic realization structures.	08	
VI	**Multirate Signal Processing and Applications of Digital Signal Processing**	Introduction and concept of Multirate Processing, Block Diagram of Decimator and Interpolator, Decimation and Interpolation by Integer numbers Multistage Approach to Sampling rate converters. Application of DSP for- ECG and EEG signals analysis, echo cancellation and sub-band coding of speech signal	07	CO6
		Self-learning Topics:	07	

		Polyphase Structures in Multirate DSP, Fractional Sampling Rate Conversion (L/M conversion), Filter Banks and Perfect Reconstruction Systems, Wavelet Transform in Multirate Systems in IoT and Smart Sensors Real-time DSP implementation using FPGA/DSP processors		

Text Books:

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

References:

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach ", 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", PrenticeHall of India, 2006.
4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011
6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach",Wiley 2002.

Online References:

Sr. No.	Website Name
1.	Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2.	Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur https://nptel.ac.in/courses/108/105/108105055/

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).

- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211503	Digital VLSI	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211503	Digital VLSI	20	20	40	60	2.5	--	--	100

Rationale:

This syllabus is designed to provide a comprehensive foundation in Digital VLSI design, focusing on CMOS technology, MOSFET operation, combinational and sequential logic design, semiconductor memories, data path subsystems, and RTL design methodologies. The course aims to build theoretical understanding and practical design skills required for modern integrated circuit design and semiconductor industries. The syllabus bridges academic concepts with industrial applications, enabling students to understand VLSI design flow, analyze performance trade-offs, and design digital systems using different CMOS design styles

Course Objectives:

1. To introduce process flow of VLSI Design.
2. To understand MOSFET operation from a VLSI design perspective.
3. To learn VLSI design performance metric and various tradeoffs.
4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles.
5. To provide an exposure to RTL design and programming.

Course Outcomes:

1. Know various tools, processes and fabrication techniques used in VLSI Design.
2. Explain working of various CMOS combinational and sequential circuits used in VLSI Design.

3. Understand different digital design styles such as structural, dataflow, and behavioral modeling
4. Derive and analyze performance parameters of semiconductor memory circuits and CMOS building blocks
5. Relate performance parameters with design parameters of VLSI circuits and Datapath subsystems.
6. Select suitable circuit architecture, design style and RTL methodology for given applications.

Prerequisite: Electronic Devices and Circuits, Digital System Design and Linear Integrated Circuits

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to VLSI Design and MOSFET Fundamentals and CMOS Fabrication**	Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances. MOSFET scaling, short channel effects. Novel MOSFET Architectures: FinFET, GAA-FET, CNTFET, NMOS and CMOS, Lambda based design rules.	07	CO1
		Self-learning Topics: Prerequisite: Introduction of Diode, BJT, JFET, MOSFET Moore's Law and technology scaling trends, Recent advancements in semiconductor fabrication technologies, Case study on modern VLSI chips and fabrication nodes.	07	
II	**Combinational Logic Circuits**	1. CMOS inverter operation, Voltage Transfer Characteristics (VTC), Noise Margins, Layout of CMOS Inverter. 2. Realization of CMOS NAND gate, NOR gate and Complex CMOS Logic Circuits.	07	CO2
		Self-learning Topics: Stick diagrams and layout optimization techniques, Power-delay tradeoff in CMOS circuits, Applications of CMOS logic in modern processors and embedded systems	07	
III	**MOS Design Styles and Sequential Circuits**	Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C2MOS. Setup time, hold time, clocked CMOS SR Latch, CMOS JK Latch, MS JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles. Realization of Shift Register, MUX, Decoder using above design styles, 1-bit full adder.	07	CO3

		Self-learning Topics: Comparative study of logic families, Clock skew and metastability issues, Design challenges in low power VLSI system	07	
IV	**Semiconductor Memories and Memory Design**	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM. Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory. Memory organization and applications in digital systems.	08	CO4
		Self-learning Topics: Emerging memory technologies such as MRAM and ReRAM, Memory hierarchy in computer systems, Cache memory concepts and applications	08	
V	**Data Path Subsystems and Interconnect Design**	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier. On chip clock generation and distribution. Interconnect delay model, interconnect scaling and crosstalk	08	CO5
		Self-learning Topics: Low power Datapath design techniques, Challenges in high-speed VLSI interconnects, Case study of arithmetic units in microprocessors	08	
VI	**RTL Design and System Implementation**	1. High Level state machines, RTL design process. 2. RTL design of Soda dispenser machine. 3. RTL design of FIR Filter and introduction to HDL based implementation	08	CO6
		Self-learning Topics: Introduction to Verilog/VHDL HDL coding styles, FPGA based implementation flow, RTL synthesis and verification methodologies.	08	

Text Books:

1. Neil H. E. Weste and David Harris, “CMOS VLSI Design: A Circuits and Systems Perspective”, Pearson Education, 4th Edition.
2. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, Tata McGraw Hill, 3rd Edition.
3. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits”, Pearson Education, 2nd Edition.

References:

1. Douglas A. Pucknell and Kamran Eshraghian, “Basic VLSI Design”, Prentice Hall of India.
2. John P. Uyemura, “Introduction to VLSI Circuits and Systems”, Wiley India.
3. Wayne Wolf, “Modern VLSI Design: System-on-Chip Design”, Pearson Education.
4. M. Morris Mano and Michael D. Ciletti, “Digital Design”, Pearson Education.

5. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley IEEE Press.

Online References:

Sr. No.	Website Name
1	NPTEL/SWAYAM Course: CMOS Digital VLSI Design by Prof. Indranil Sengupta (IIT Kharagpur) https://onlinecourses.nptel.ac.in
2	NPTEL/SWAYAM Course: VLSI Design Flow by IIT faculty https://swayam.gov.in

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**

2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212504	Computer Communication Networks Laboratory	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14212504	Computer Communication Networks Laboratory	--	--	--	--	--	25	25	50

Lab Objectives:

1. Introduce students to the practical aspects of networking, including media types, network devices, addressing, and layered architecture as per the OSI and TCP/IP models.
2. Enable hands-on experience with configuring network devices such as routers and switches using simulation tools like Cisco Packet Tracer.
3. Foster practical skills in analyzing and simulating communication protocols such as ARQ, routing protocols, and application layer services using NS2, NetSim, and Wireshark
4. Develop problem-solving abilities by troubleshooting real-world network issues related to connectivity, addressing, and protocol behavior across OSI layers.
5. Promote project-based learning through the design and simulation of sustainable, secure, and scalable network models.

6. Support career readiness by building competencies essential for roles such as Network Engineer, Network Administrator, and Systems Analyst—aligned with NEP 2020's emphasis on vocational and employable skills.

Lab Outcomes: Student will be able to

1. Design small to medium-sized computer networks by selecting appropriate transmission media, end devices, and interconnecting components to meet specified user requirements.
2. Configure routers and Ethernet switches for static and dynamic routing protocols (RIP, OSPF, BGP, EIGRP) using industry tools
3. Develop basic scripts or use simulation tools to demonstrate and test network communication and protocols (e.g., ARQ, TCP, UDP)
4. Simulate real-world network scenarios using tools like Cisco Packet Tracer, NS2, or Wireshark, and analyze protocol behavior and performance metrics.
5. Diagnose and troubleshoot connectivity issues across multiple OSI layers, using both command-line tools and protocol analyzers.
6. Demonstrate technical competence and professional readiness for roles such as Network Engineer, System Administrator, or Network Analyst, in alignment with NEP 2020's skill-based and career-oriented education.

Suggested List of Experiments

Sr No	List of Experiments	Hrs	LO
01	Use basic networking commands (e.g., ifconfig, ping, netstat, traceroute) on Linux/Netkit.	2	LO1
02	Prepare and test straight-through and crossover UTP cables using RJ-45 and cable tester.	2	LO1
03	Design and configure various topologies in Cisco Packet Tracer (Star, Ring, Mesh, Bus).	2	LO1
04	Configure static routes and analyze routing tables using Cisco Packet Tracer.	2	LO2
05	Implement RIP, OSPF, BGP, and EIGRP protocols in simulation.	2	LO2
06	Perform subnetting and VLSM calculations with simulation setup.	2	LO3
07	Configure DHCP, DNS, FTP, TELNET, or SMTP servers in a simulated environment.	2	LO3
08	Capture and analyze TCP/UDP headers using Wireshark; perform checksum verification	2	LO4
09	Compare ALOHA, Slotted ALOHA, CSMA/CD using simulation (e.g., NetSim).	2	LO5
10	Simulate Stop-and-Wait and Sliding Window ARQ protocols in NS2/C++	2	LO4

11	Simulate congestion control (TCP Slow Start, Fast Retransmit) using NS2/NS3.	2	LO5
12	Compare IPv4 vs IPv6 packet structure using packet analysis tools	2	LO6
13	Configuring WEP on a Wireless Router	2	LO6
14	Examining Network Address Translation (NAT)	2	LO6

Sr No	List of Assignment	Hrs
1	Network Topologies: Compare and contrast different network topologies (LAN, WAN, MAN, Wi-Fi). OSI Model: Explain the OSI model and its layers, providing examples of each layer's functions.	01
2	Explain the functions of protocols like DNS, DHCP, HTTP, FTP, and SMTP.	01
3	Analyze a real-world network failure or security breach, identifying causes and proposing solutions.	01
4	Design a network architecture for a small business or organization, considering scalability, security, and performance.	01
5	Design a Network for a Small Business	01
6	Use a network simulator (e.g., Cisco Packet Tracer, NS2) to design and test a network.	01

Assessment:

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

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212505	Discrete Time Signal Processing Laboratory	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14212505	Discrete Time Signal Processing Laboratory	--	--	--	--	--	25	25	50

Lab Objectives:

1.To introduce students to digital signal generation and representation in time and frequency domains.

2. To provide practice in frequency domain analysis using DFT, IDFT, and ZTransform techniques.

3. To develop skills for performing convolution operations using circular and block convolution methods. 4. To guide students in designing and simulating FIR and IIR digital filters using standard design techniques.

5. To build awareness of implementation-level challenges such as finite word-length effects and quantization.

6.To develop a DSP-based application as a case study, demonstrating effective problem-solving

Lab Outcomes: Student will be able to

1. Apply software tools to generate and visualize basic signals in the time and frequency domain.

2. Analyze discrete-time systems using Z-transform, DFT, and IDFT.

3. Perform convolution operations and compare the output of circular and block convolution methods.

4. Design and simulate FIR and IIR digital filters using standard design procedures.

5. Evaluate filter realizations and study the effect of coefficient quantization using simulation tools.

6.Create a DSP-based application as a case study, focusing on problem-solving

Suggested List of Experiments:

Sr No	List of Experiments	Hrs	LO
01	Plot the elementary discrete time signals.	2	LO1
02	To study Z-Transform using a pole-zero plot	2	LO2
03	To study linear convolution.	2	LO3
04	To study Circular convolution.	2	LO3
05	To perform Discrete Fourier, Transform & Inverse Discrete Fourier Transform.	2	LO2
06	To implement the Overlap-Add method for processing long data sequences using DFT/FFT.	2	LO3
07	To implement the Overlap-Save method for processing long data sequences using DFT/FFT.	2	LO3
08	To find the effect of poles and zeros on FIR/IIR filters (Frequency response).	2	LO4
09	To design linear phase filters and plot magnitude and phase responses.	2	LO4
10	To Design a FIR filter by window method.	2	LO4
11	To Design a FIR filter by frequency sampling method.	2	LO4
12	Design of Butterworth IIR Filter using Impulse invariant method	2	LO4
13	Design of Butterworth IIR Filter using Bilinear Transformation method.	2	LO4
14	To design Chebyshev-I IIR filters.	2	LO4
15	To measure the effect of finite word length on FIR/IIR filter performance.	2	LO4
16	To realize FIR and IIR Filters using Direct Form, Cascade/Parallel form structures.	2	LO5
17	Perform down sampling (decimation) of a signal by a factor of M	2	LO6
18	Perform up sampling (interpolation) by a factor of L	2	LO6

19	To perform coefficient quantization error using truncation and rounding.	2	LO5
20	To design a FIR/IIR filter to remove a noise (sine wave with a given frequency) corrupting ECG/Speech signal.	2	LO6
21	Application oriented suggested case study topics- ● Noise reduction in audio signals using filtering techniques ● Speech signal enhancement using FFT-based methods ● Image denoising using basic DSP filters ● Audio compression using basic transform methods ● Music equalizer design using digital filters ● Signal smoothing for sensor data (e.g., temperature or motion sensors) ● Voice activity detection using simple DSP techniques Power spectrum analysis of real-world signals using FFT	2	LO6

Sr No	List of Assignments	Hrs
1	Assignment based on DFT, FFT, block convolution	01
2	Assignment based on FIR & IIR filter designing	01
3	Assignment based on Filter structures	01
4	Assignment based on applications of discrete time signal processing	01

Online Resources:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc23_ee33/preview?utm_source
2.	https://onlinecourses.nptel.ac.in/noc25_ee26/preview?utm_source
3.	https://in.mathworks.com/discovery/digital-signal-processing.html?utm_

Assessment:

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

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212506	**IDEA LAB 5 - (Innovation Design Engineering and Apply)**	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14212506	**IDEA LAB 5 - (Innovation Design Engineering and Apply)**	--	--	--	--	--	**25**	**25**	**50**

Rationale:

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation. To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SDG. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills. The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a structured assessment framework is implemented.

1. Project assessment is carried out using standardized IDEA Lab rubrics with multiple evaluation parameters.
2. One of the key parameters is **Engineering Subject-Based Assessment**, which focuses on the effective application of same-semester subject knowledge in project work, ensuring integration of theoretical learning with practical implementation.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.

- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Students must ensure that their IDEA Lab project meaningfully incorporates concepts from all core subjects of the current semester and maintain a project logbook as evidence of subject-wise application.
- Faculty in-charge must guide students to apply concepts from subjects studied in the same semester to their IDEA Lab projects.
- The term work evaluation will partially reflect the effective application of subject-specific knowledge.
- Faculty should regularly review the integration of academic content within the project work.

2) Implementation Strategy – IDEA Lab Learning Model

- A theme-based learning structure shall be implemented where each semester is anchored to a broad contextual domain such as Healthcare, Smart Cities, Energy, Agriculture, or Governance, providing the overall learning direction.
- From the identified theme, a system-level, open-ended problem statement shall be defined, serving as a solution-neutral framework that enables interdisciplinary thinking and innovation.
- The learning sequence shall follow a structured flow: Theme → Problem Statement → Same Semester Subject Application → Design–Implementation Experience, ensuring progressive transformation from context to solution.
- Themes shall provide the context (defining the domain of work), while problem statements shall provide the purpose, enabling students to identify meaningful real-world challenges.
- Subjects shall be treated as engineering tools, where each subject contributes specific knowledge components to solve different aspects of the problem.
- Students shall be encouraged to take ownership of their learning and projects, fostering curiosity, exploration, social relevance, and a mindset of creative risk-taking.
- Structured brainstorming and ideation sessions shall be conducted at the beginning of the semester to guide students in problem identification and development of solution pathways through collaborative and interdisciplinary thinking.
- Guest lectures and expert talks shall be organized by inviting industry experts, researchers, and innovators aligned with the semester theme and subject areas to provide exposure to real-world challenges, trends, and opportunities.

- A mechanism shall be implemented to ensure uniqueness and originality of projects by systematically reviewing ideas to avoid duplication and encouraging novel, technology-driven solutions.
- Platforms shall be created for collaborative learning and discussion, enabling students to present ideas, receive peer and mentor feedback, and refine solutions through iterative engagement.
- Content beyond syllabus for as subject shall be integrated with IDEA Lab themes and problem statements to ensure deeper interdisciplinary application and enhanced conceptual understanding.
- Preference shall be given to ensuring same-semester academic alignment, where subject faculty contribute to effective contextual integration of project-based learning.
- Continuous monitoring and documentation shall be ensured through logbooks, milestone tracking, and periodic progress reviews to maintain academic rigor and outcome alignment.
- Coordination with subject faculty shall be ensured for effective mapping of theoretical concepts into project execution and for evidence-based term work assessment.
- The IDEA Lab shall function as an institutional mechanism for implementing the CDIO (Conceive–Design–Implement–Operate) framework, promoting experiential and outcome-based learning through structured mini-projects.

Implementation Notes:

- Guide will assess subject's contribution using specific evidence such as:
    - Logbooks
    - Subject-specific outputs (e.g., simulations, designs)
    - Paper publications or review presentations

3) Guidelines for Assessment

Assessment Month	**Marks**
Month 1 (Formative 1)	25 marks
Month 2 (Formative 2)	25marks
Month 3 (Formative 3)	25 marks

Total Assessment Structure

Component	Marks	Assessed By
Term work – Project Execution	25 Marks	Project Guide – Average of all innovation
Viva Voce (Final Evaluation)	25 Marks	External Examiner

Criteria	Excellent (10)	Good (8)	Satisfactory (6)	Needs Improvement (4)
1. Innovation	Highly original and disruptive idea solving a real-world or futuristic problem	Novel idea with a creative approach to a known problem	Moderately innovative; adapts existing solutions	Common or repetitive idea with minimal novelty
2. Design	User-centric, systematic design with professional-level tools, prototyping, or simulations	Logical structure; clearly presented using standard tools	Functional design but limited user perspective or refinement	Poor or confusing design with lack of user consideration
3. Engineering	Applies concepts from all same-semester subjects with clear integration and interdisciplinary depth	Applies knowledge from 4 or more subjects with relevance	Applies 2–3 subjects with moderate clarity	Applies 1 subject with weak or shallow connection
4. Implementation	Complete, fully functional prototype with rigorous testing and real-world validation	Working model with minor errors; partially tested	Prototype is incomplete; basic testing or debug attempt	Poorly implemented; fails to function properly
5. Application	Strong real-world relevance with alignment to SDGs/National Missions; impact clearly identified	Clear practical use-case with user/market relevance	Some practical value but limited clarity on impact	Vague or irrelevant application; weak user connect

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142215701	Cloud Computing	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)	Term work	Pract / Oral	Total
		IA T-I	IA T-II	Total					
142215701	Cloud Computing	20	20	40	60	2.5	--	--	100

Rationale:
The syllabus is designed to build a strong foundation and progressive understanding of **cloud computing**, aligning with current industry demands and emerging technologies.

Course Objectives:

1. Understand the fundamentals of cloud computing.
2. Appreciate the importance of virtualization in cloud computing
3. Understand various cloud computing services and platforms
4. Understand application design concepts in cloud
5. Understand the security aspects of cloud computing

Course Outcomes:

1. Explain the fundamentals of cloud computing.
2. Interpret the significance of virtualization in the context of cloud computing

3. Describe cloud computing services working on AWS, Azure and Google cloud platforms
4. Explain application design aspects of cloud computing
5. Interpret security aspects to cloud computing.
6. Explain advances in cloud computing in terms of multimedia cloud, fog, edge computing and real applications of cloud.

Prerequisite:

1. Computer Communication Network
2. Digital Encryption System

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Cloud**	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components, Comparing of Cloud Computing with Peer-to-Peer architecture, Client Server, Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Service Models- (IaaS,PaaS,SaaS,)	**07**	CO1
		Self-learning Topics: Prepare a comparison chart of cloud vs traditional computing, create a diagram showing cloud architecture, Explore free-tier services on AWS/Azure, Case study: Use of cloud in education or banking	**07**	
II	**Virtualization**	Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Design Requirements and Providers – Virtualization at OS level – Middleware support for Virtualization– Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support - Virtualization of CPU, Memory and I/O Devices, Hardware support for Virtualization in intel x86 processor – CPU Virtualization – MemoryVirtualization and I/O Virtualization – Virtualization in Multicore processors	**08**	CO2
		Self-learning Topics:	**08**	

		Install a virtualization tool (VirtualBox/VMware), Compare Full Virtualization vs Para-Virtualization		
III	**Regularization and Optimization Techniques**	Compute Services - Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines. Storage Services - Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage. Database Services - Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database, Windows Azure Table Service. Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services, Content Delivery Services - Amazon CloudFront, Windows. Azure Content Delivery Network. Analytics Services - Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Windows Azure HDInsight. Deployment & Management Services - Amazon Elastic Beanstalk, Amazon CloudFormation. Identity & Access Management Services - Amazon Identity & Access Management, Windows Azure Active Directory. Open Source Private Cloud Software - CloudStack, Eucalyptus, OpenStack	**08**	CO3
		Self-learning Topics: Big Data analytics in cloud, Role of IAM in cloud security, **Case Study:** Choose one company (e.g., Netflix, Flipkart) and identify which cloud services they might use.	**08**	
IV	**Cloud Application Design**	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Upgradation, Performance, Cloud Application Design Methodologies - Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services, Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach	**08**	CO4

		Self-learning Topics: Recommender System, End-to-End Speech Recognition and Machine Translation	**08**	
V	**Cloud Security**	Security for Virtualization Platform – Host security for SaaS, PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability –Data Integrity – Cloud Storage Gateways – Cloud Firewall, AAA Administration for Clouds -AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds Resource utilization.	**07**	CO5
		Self-learning Topics: cloud security architecture including firewall, IAM, and storage security. Compare security responsibilities in SaaS, PaaS, and IaaS. Multi-factor authentication (MFA)	**07**	
VI	**Cloud Computing Applications**	Cloud Computing for Health care, Education, Transportation, Manufacturing. Industry, Energy System, Mobile Computing Multimedia Cloud - Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming Case Studies - Live Video Streaming App , Video Transcoding App, Edge Computing, FOG Computing	**07**	CO6
		Self-learning Topics: Create a Live streaming app.	**07**	
	Total		**90**	

Text Books:

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madisetti
2. Mastering Cloud Computing: Foundations and Applications Programming Paperback – by Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Publisher: Morgan Kaufmann
3. Amazon Web Services For Dummies (For Dummies Series) Paperback by Bernard Golden, Publisher: John Wiley & Sons
4. "The Cloud Computing Book: The Future of Computing Explained" , Douglas E. Comer
5. Cloud Computing for Dummies, Judith Hurwitz Daniel Kirsch

References:

1. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah by Kogent Learning Solutions , Publisher : Dreamtech Press
2. Cloud Computing Concepts Technology and Architecture - Erl second hand book online from UsedBooksFactory
3. Practical Cloud Security by Chris Dotson, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492037514
4. AWS Whitepapers & Guides https://aws.amazon.com/whitepapers/
5. Azure whitepapers https://azure.microsoft.com/en-in/resources/whitepapers/
6. Google Cloud whitepapers https://cloud.google.com/whitepapers

Online References:

Sr. No.	Website Name
1.	NPTEL Swayam Course on Cloud computing By Prof. Soumya Kanti Ghosh https://nptel.ac.in/courses/106/105/106105167/
2.	Cloud Computing and Distributed Systems By Prof. Rajiv Misra https://onlinecourses.nptel.ac.in/noc22_cs18/preview
3.	Google Cloud Computing Foundation Course https://nptel.ac.in/courses/106/105/106105223

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.

- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142215702	Data Compression and Cryptography	3	--	--	45	--		45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142215702	Data Compression and Cryptography	20	20	40	60	2.5	--	--	100

Rationale:

The subject *Data Compression and Cryptography* integrates two critical areas of information technology—efficient data representation and secure data transmission. It begins with fundamental techniques for data, image, audio, and video compression, including popular standards like JPEG, MPEG, and AAC, equipping students with the ability to reduce storage and transmission costs without significant loss of quality. The second half focuses on cryptographic principles essential for securing digital communications, covering both symmetric and asymmetric key systems, including AES, RSA, and hash functions. Through the study of number theory, encryption algorithms, and system-level security mechanisms such as firewalls and biometric authentication, students gain a holistic understanding of data confidentiality, integrity, and access control. This subject lays a vital foundation for careers in cybersecurity, multimedia systems, and secure software development, preparing students for real-world challenges in the digital and connected age.

Course Objectives: Understand various building services systems.

1. **To understand** fundamental concepts of multimedia data compression and apply various text and image compression techniques along with relevant standards.
2. **To analyze and select** appropriate lossless and lossy compression techniques for audio and video applications.

3. **To study** principles of cryptography and differentiate between symmetric and asymmetric cryptographic systems and standards.
4. **To apply** number theory concepts such as modular arithmetic and prime number operations in solving cryptographic problems.
5. **To analyze** public key cryptography algorithms and understand mechanisms ensuring confidentiality, integrity, authentication, and non-repudiation.
6. **To understand** system security mechanisms, protection techniques against security threats, and ethical issues related to computer and information security.

Course Outcomes:

1. Apply various compression techniques for text and understand image compression and its standards.
2. Select suitable compression techniques for specified lossless and lossy audio and video applications.
3. Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards.
4. Apply number theory concepts to solve the cryptographic problems.
5. Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6. Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Data Compression**	Data compression, modelling and coding, Lossless and Lossy Compression, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW. Image Compression DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards	08	CO1
		Self-Learning Topics: Image compression quality metrics (PSNR, MSE), Image compression in medical imaging, Compression artifacts analysis	08	
II	**Video and Audio Compression**	Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder. Sound, Digital Audio, μ-Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard.	08	CO2
		Self-Learning Topics: Introduction to H.265 and AV1, Types of Video Frames • I-Frames (Intra frames)	08	

		• P-Frames (Predicted frames) • B-Frames (Bidirectional frames) • Group of Pictures (GOP) structure		
III	**Data Security**	Security Goals, Cryptographic Attacks and Techniques. Symmetric Key: Substitution Cipher, Transposition Cipher, Stream and Block Cipher. DES, double DES and triple DES, AES	07	CO3
		Self-Learning Topics: Frame Relay vs HDLC Emerging MAC protocols in 5G networks.	07	
IV	**Number Theory**	Prime Numbers, Fermat's and Euler's Theorem. Chinese Remainder Theorem.	07	CO4
		Self-Learning Topics: Prime number generation, Prime factorization methods, Importance of primes in cryptography	07	
V	**Asymmetric Key Cryptography**	Principles of Public Key Cryptosystem, RSA, Key Management, Deffie-Hellman Key Exchange. Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards.	08	CO5
		Self-Learning Topics: Cryptographic application in Blockchain (conceptual)	08	
VI	**System Security**	Intrusion Detection System, Secure Electronic Transactions. Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking.	07	CO6
		Self-Learning Topics: More applications, Protection against attacks, Secure communication protocols	07	
	Total		90	

Text Books:

1. Khalid Sayood, 3rd Edition, |Introduction to Data Compression|, Morgan Kauffman
2. Mark Nelson, Jean-Loup Gailly,‖The Data Compression Book‖, 2nd edition, BPB Publications

3. William Stallings,|Cryptography and Network Security Principles and Practices 5th Edition‖, Pearson Education.

4. Behrouz A. Forouzan, |Cryptography and Network Security‖, Tata McGraw-Hill.

References:

1. David Salomon, |Data Compression: The Complete Reference‖, Springer.
2. Matt Bishop, |Computer Security Art and Science‖, Addison-Wesley.
3. Bernard Menesez, | Network Security and Cryptography| Delmar Cengage Learning, 7th Edition.

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142215703	Data Structure and Algorithm	3	--	–	45	--	–	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142215703	Data Structure and Algorithm	20	20	40	60	2.5	–	–	100

Rationale:

The syllabus is designed to build a strong foundation and progressive understanding of **Data Structure & Algorithm**, aligning with current industry demands and emerging technologies.

Course Objectives:

1. To Introduce the fundamental knowledge & need of Data Structures.
2. To Abstract the concept of Algorithm and these concepts are useful in problem solving.
3. To Implement fundamental knowledge and applications of Stack, Queue, Linked List, Trees, Graphs etc.
4. To Understand the working of different Sorting, Searching & Hashing techniques
5. To understand about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course Outcomes:

1. Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis.
2. Apply various operations on Stack and Queue.
3. Ability to demonstrate the operation of Linked list.
4. Ability to demonstrate and apply Trees & Graph data structures.
5. Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6. Describe the hash function and concepts of collision and its resolution methods.

Prerequisite: Skill Lab: Python Programming

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Data Structure & Algorithm**	Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures. Algorithm: Performance characteristics of algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Introduction to Asymptotic Analysis and Notations.	07	CO1
		Self-Learning: Implement Control Structures, Arrays, Recursion, Pointers, Structures, Memory Allocation Techniques, Self-referential structures in any programming language like C/C++/Python.	07	
II	**Stack & Queue**	Introduction to Stack, ADT of Stack, Operations on Stack, Array Implementation of Stack. Applications of Stack- Infix to Postfix Expression Conversion, Infix Expression to Prefix Expression Conversion, Postfix Expression Evaluation. Introduction to Queue, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction to Double Ended Queue. Applications of various types of Queue	08	CO2
		Self-Learning: Well form-ness of Parenthesis using Stack. Implementation of Infix, prefix and postfix conversions, types of queues using C/C++/Python.	08	

III	**Linked List**	Introduction, Linked List v/s Array, Representation of Linked List, Types of Linked List - Singly Linked List, Doubly Linked List. Operations on Singly Linked List and Doubly Linked List. Singly Linked List Application-Polynomial Representation and Addition, Doubly Linked List Application.	08	CO3
		Self-Learning: Implementation of Stack and Queue using Singly Linked List using C/C++/Python.	08	
IV	**Trees & Graph**	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree- Expression Tree, Huffman Encoding. Graph: Introduction, Graph Terminology, Memory Representation of Graph, Operations Performed on Graph. Graph Traversal, Breadth First Search, Depth First Search, Applications of the Graph, Shortest Path, Minimum Spanning Tree.	08	CO4
		Self-Learning: Implementation of Tree and Graph algorithms using C/C++/Python.	08	
V	**Searching & Sorting**	Searching: Searching Methods, Sequential Search, Index Sequential Search, Binary Search. Sorting: Internal and external sorting, Bubble Sort, Insertion sort, Selection Sort, Quick Sort, Merge Sort, Comparison of Sorting Techniques Based on Their Complexity	07	CO5
		Self-Learning: Implementation of searching and sorting algorithms using C/C++/Python.	07	
VI	**Hashing**	Hashing-Concept, Hash Functions, Hash Table, Common hashing functions. Collision resolution Techniques, Linear Probing. Quadratic Probing, Double Hashing	07	CO6
		Self-Learning: Implementation of hashing concepts using C/C++/Python.	07	
	Total		90	

Text Books:

1. Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and its Applications", McGraw-Hill Higher Education
2. "Fundamentals of Computer Algorithms" Ellis Horowitz, Sartaj Sahani and Sanguthevar Rajasekaran, Second Edition, Universities Press (India) Pvt. Ltd.

3. "Learning with Python" Allen Downey, Jeffrey Elkner, Chris Meyers, Dreamtech Press

Reference Books:

1. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984
2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGrawHill Edition.

Online References:

Sr. No.	Website Name
1.	Course: Data Structures And Algorithms, IIT Delhi Prof. Naveen Garg https://nptel.ac.in/courses/106102064
2.	Course: Programming, Data Structures And Algorithms Using Python By Prof. Madhavan Mukund | Chennai Mathematical Institute https://onlinecourses.nptel.ac.in/noc26_cs79
3	Course: Data Structures By Dr.R.Kathiroli & Dr. T. Sudhakar **https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cs05**

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.

- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142215704	Sensor Technology	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142215704	Sensor Technology	20	20	40	--	2.5	--	--	100

Rationale:

The Sensor Technology course provides fundamental knowledge of sensing principles, transducers, MEMS devices, and wireless sensing technologies used in modern engineering systems. It develops skills in sensor selection, data acquisition, and signal conditioning for accurate measurement and real-time applications. The course prepares students to design and apply sensor-based solutions in IoT, industrial, healthcare, automotive, and environmental domains.

Course Objectives:

1. To understand various physical parameters and its sensing techniques
2. To familiarize about MEMS sensors and Actuators
3. To introduce wireless sensing technologies
4. To develop understanding about signal conditioning using ADC and DAC
5. To provide insight into various sensor applications

Course Outcomes:

1. Understand the transduction principal of various sensors.

2. Select sensors suitable for required application
3. Analyze wireless sensing techniques
4. Design the data acquisition system
5. Identify signal conditioning method for particular application
6. Create an application using various sensor technologies

Prerequisite:

Engineering Physics-II, Electronic Devices & Circuits and Linear Integrated Circuits

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	Classification of Sensors: The sensors are classified with criteria like primary physical quantity to be sensed, transduction principle, material and technology used and application. Criteria to choose a Sensor: Accuracy, Environmental condition, Range, Calibration, Resolution, Cost and Repeatability. Digital sensors: Principle and its advantage over analog sensors. Smart Sensors: Low-power, Self diagnostic and Self- calibration	07	CO1
		Self-learning Topics: Study the classification of sensors, criteria for sensor selection, principles and advantages of digital sensors over analog sensors, and the features of smart sensors such as low power consumption, self-diagnosis, and self-calibration.	07	
II	**Types of Sensors**	Temperature Sensors: RTD, Thermocouple and Thermistors sensor. Proximity Sensors: Inductive (LVDT), Capacitive, Photoelectric and Ultrasonic sensors. Chemical Sensors: Gas, Smoke, Conductivity and pH sensor. Other Sensors: Optical, Infrared (IR), Sound, Motion, Pressure, Level, Moisture, Humidity, Laser, Image and GPS sensor**.**	07	CO2
		Self-learning Topics: Study the working principles, characteristics, and applications of temperature, proximity, chemical, optical, infrared, sound, motion, pressure, level, moisture, humidity, laser, image, and GPS sensors used in modern sensing and automation systems.	07	
III		MEMS SENSORS: General design methodology, techniques for sensing, Pressure sensor, Mass Flow sensor, Acceleration sensor, Angular Rate sensor	08	CO3

	MEMS Sensors and Actuators	and Gyroscopes, Micro machined microphones, Chemical sensors, Taguchi Gas sensor, Combustible Gas sensors. MEMS ACTUATORS: Techniques for actuation, Digital Micro mirror Device, Micro Machined Valves**.**		
		Self-learning Topics: Study the design methodology, sensing and actuation techniques of MEMS devices, including MEMS sensors such as pressure, flow, acceleration, gyroscope, microphone, and gas sensors, along with MEMS actuators like digital micromirror devices and micromachined valves.	08	
IV	**Wireless Sensing Technologies**	Bluetooth: Concepts of Pico net, Scatter net, Link types, Network connection establishments. ZigBee: components, architecture, network topologies. Ultra Wide Band (UWB), Near Field Communication (NFC) and RFID: technical requirements, components and characteristics. WLAN (WiFi) : WLAN Equipment, WLAN topologies , IEEE 802.11 Architecture	08	CO4
		Self-learning Topics: Study the concepts, architecture, components, topologies, characteristics, and applications of wireless communication technologies including Bluetooth, ZigBee, UWB, NFC, RFID, and WLAN (WiFi) used in modern networking and IoT systems.	08	
V	**Data Acquisition and Signal Conditioning**	Fundamentals of Data Acquisition: Analog and Digital data acquisition system with different configurations, Data loggers, Noise and interference. Signal Conditioning: Wheatstone Bridge, Flash ADC, R2R DAC. Utilization of Signal conditioning circuits for Temperature, Pressure, Optical, Strain gauges, Displacement and piezoelectric Transducers	07	CO5
		Self-learning Topics: Study the fundamentals of analog and digital data acquisition systems, data loggers, noise and interference, and the role of signal conditioning circuits such as Wheatstone bridge, Flash ADC, and R2R DAC in processing signals from various transducers and sensors.	07	
VI		Onboard Automobile sensing system, home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring, Biomedical Sensing Applications. Radio sensors for industrial	08	

	Sensor Applications	applications, Radio Astronomy, Remote Sensing, Ground Penetrating Radars, Underwater sensing, LIDAR.		CO6
		Self-learning Topics: Study the applications of sensors in automobiles, home appliances, aerospace, environmental monitoring, biomedical systems, industrial radio sensing, radio astronomy, remote sensing, ground penetrating radar, underwater sensing, and LIDAR technologies.	08	
	Total		90	

Text Books:

1. D.V.S. Murthy, "Transducers and Instrumentation", PHI Learning, 2nd edition,2013.
2. D. Patranabis - Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
3. Antti V. Raisanen, Arto Letho, "Radio Engineering for Wireless Communication and Sensor Application", Artech House Mobile Communciacaiotns Series, USA, 2003.
4. Dr.Raj Kamal, Internet of Things(IoT) , Architecture and Design Principles. McGraw Hill Education.
5. Sensoors and Signal Conditioning, Ramon Pallas Areny, Jphn G. Webster, 2nnd edition, John Wiley and Son, 2000.
6. Vijay K. Garg, "Wireless Communication and Networking", Morgan-Kaufmann Series in Networking, Elsevier, 2010.

References:

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, 2004.
2. Micro Electro Mechanical System Design, James J. Allen, Taylor and Francis, 2005
3. A.K. Sawhney, "A Course in Electrical and Electronic Mesurements and Instrumentations", Dhanpatri & Co. 19th edition, 2011.
4. Nathan Ida, "Sensor, Actuators and their interfaces: A Multidiscilinnary Introduction", 2nd edition, IET Control, Robotics and Sensors series127,2020,
5. Instrumentation Devices and System, C.S. Rangan, G.R. Sarma, V.S. Mani, TMH,1997.
6. Jacob Fraden Handbook of Modern Sensors Physics, Designs, and Applications Fourth Edition, Springer, 2010.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108/108/108108147/
2.	https://www.youtube.com/watch?v=vjhp0zTXEsc

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14412509	**Skill lab Linux and Networking**	**--**	**--**	**2**	**--**	**--**	**30**	**--**	**30**	**1**

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14412509	**Skill lab Linux and Networking**	**--**	**--**	**--**	**--**	**--**	25	--	25

Lab Objectives:

1. Install Linux and implement standard Linux commands
2. Study basic theory of Linux Operating System
3. Implement the system administrative functionality
4. To write shell script programs to solve problems
5. Study basic commands of networking
6. Develop implementation skill of different servers on Linux

Lab Outcomes:

1. Install Linux using a different platform and execute standard Linux commands.
2. Describe the basic knowledge of Linux Operating System
3. Deploy the system administrative functionality
4. Solve the problems using shell script programming
5. Develop network-based applications
6. Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Pre-requisite: C Programming

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Overview of Linux**	Installing Software on Debian Based Linux: Debian, Ubuntu, Kali Linux. Overview of Unix and Linux architectures, Linux files system, Linux standard directories, Linux Directory Structure, Basic Linux Commands, Linux Networking commands, Viewing Files and the Nano Editor, Editing Files in Vi, Graphical Editors, Deleting, Copying, Moving, and Renaming Files	05	LO1
II	**Linux OS**	Linux Design Principles, Linux Booting Process, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output, Inter-process Communication.	05	LO2
III	**System Administration**	Common administrative tasks, Configuration and log files, Role of system administrator, managing user accounts –adding, deleting users, changing permissions and ownerships, Creating and managing groups, Modifying group attributes. Temporary disabling of user's accounts, Creating and mounting file system, becoming super user using su, Getting system information with username, host name. Disk partitions & sizes, users, kernel, installing and removing packages, rpm command.	05	LO3
IV	**Shell programming**	Basics of shell programming, various types of shell available in Linux, Shell programming in bash, Conditional statements, Looping statements, Case statements, Parameter passing and arguments. System shell variables, Shell variables, shell keywords, Creating Shell programs for automating system tasks, scheduling repetitive jobs using cron	05	LO4
V	**Linux Networking**	Basics of Network Management, setting up Dynamic and Static Addressing, Monitoring network services, Talking with DNS Servers, Remote System Administration with OpenSSH-Server & Putty. TCP/IP Networking for Linux System Administrators, DNS and hostnames, DHCP, Network Troubleshooting.	05	LO5

VI	**Servers and Configurations**	Create and configure DHCP, Mail, DNS, FTP, Squid, Apache, Telnet, Samba servers	05	LO6
	Total		60	

Sr. No.	List of Experiments	Hours	LO Mapping
1	Linux Installation process using following method CD-ROM, Network, Installation or Kickstart Installation.	2	LO1, LO2
2	Basic Linux Commands, Linux Networking commands, Basic commands to create users, change permission, software selection and installation and do changes in Grub file.	2	LO1, LO2, LO3
3	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.	2	LO2
4	Write a shell script to show various system configuration like currently logged user and his log name, your current shell, home directory, operating system type, current path setting, current working directory, show currently logged number of users, show memory information, Hard disk information like size of hard-disk, cache memory, model etc, and file system mounted.	2	LO3, LO4
5	Write a shell script to add user and password on Linux system.	2	LO3, LO4
6	Write a shell script to print last login details.	2	LO3, LO4
7	Write a shell script to upgrade and cleans the system automatically instead of doing it manually.	2	LO4
8	Write a shell script to delete all log files present inside your var/log directory.	2	LO3, LO4
9	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.	2	LO3, LO4

10	Write a awk script to find the number of characters, words and lines in a file?	2	LO3, LO4
11	Write a shell script that delete all lines containing a specified word	2	LO3, LO4
12	Write a shell script to find the factorial of given integer	2	LO3, LO4
13	Configuration of DHCP Server and Client	2	LO5, LO6
14	Configuration of DNS Server with Domain Name.	2	LO5, LO6
15	Configuration of NFS File server and transfer files to a windows client.	2	LO5, LO6
16	Setting up a Samba Server and creating a print server.	2	LO5, LO6
17	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy.	2	LO5, LO6
18	Configuration of Mail Server	2	LO5, LO6
19	Configuration of Web Server.	2	LO5, LO6
20	Configuration of FTP server and transfer files to demonstrate the working of the same.	2	LO5, LO6

Textbooks:

1. Yeswant Kanethkar – "UNIX Shell Programming", First edition, BPB.
2. Cristopher Negus – "Red Hat Linux Bible", Wiley Dream tech India 2005 edition.
3. Jason Cannon," Linux for Beginners: An Introduction to the Linux Operating System and Command line"
4. W. Stevens, Stephen Rago, "Advanced Programming in the UNIX Environment", Addison- Wesley Professional Computing Series

References:

1. Official Red Hat Linux Users guide by Redhat, Wiley Dream tech India
2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.
3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dream tech India.
4. Richard Petersen, Linux: The Complete Reference, Sixth Edition

Software Tools:

1. Install Ubuntu desktop | Ubuntu
2. Chapter 4. Quick Installation Guide Red Hat Enterprise Linux 7 | Red Hat Customer Portal
3. Installation | Kali Linux Documentation

Online Resources:

Sr. No.	Website Name
1.	How to Install a DHCP Server in Ubuntu and Debian (tecmint.com)\
2.	How to Install and Configure Postfix as a Send-Only SMTP Server on Ubuntu 16.04 | DigitalOcean
3.	Network - DHCP | Ubuntu

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 10 Marks (Attendance)

SEM-VI

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211601	Electromagnetics and Antenna	3	–	--	45	-	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211601	Electromagnetics and Antenna	20	20	40	60	2.5	--	--	100

Rationale:

The course provides a comprehensive understanding of the fundamental principles governing electric and magnetic fields, electromagnetic wave propagation, and antenna theory—key pillars of modern wireless communication systems. Beginning with static fields and Maxwell's equations, the course builds up to dynamic wave behavior in various media and power transmission using the Poynting theorem. It then transitions into antenna fundamentals, exploring radiation mechanisms, antenna parameters, and design concepts for various types of antennas including dipoles, arrays, horns, reflectors, and microstrip antennas. Emphasis on both theoretical derivations and practical applications prepares students to design, analyze, and apply antenna systems in real-world scenarios like satellite communication, radar, and mobile networks. These subject forms a crucial foundation for careers in RF engineering, telecommunications, and embedded wireless technologies.

Course Objectives:

1. Understand the basic concepts of electrostatics and magnetostatics
2. Apply Maxwell's equations in differential and integral forms to analyze time-varying electromagnetic fields and wave propagation.
3. Explain the fundamental radiation mechanisms and basic antenna concepts
4. Analyze the performance of linear and planar antenna arrays
5. Explore different types of antennas such as Yagi, Horn, Reflector, and Microstrip antennas

6. Understand the different modes of electromagnetic wave propagation

Course Outcomes:

1. Students will be able to analyze the fundamental principles of electrostatic and magnetostatic fields
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomena such as electromagnetic wave propagation in different mediums, power in EM waves.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc
4. Students will be able to implement different types of the antenna structures such as Antenna arrays
5. Design and analyse special types of antennas like Microstrip antenna and reflector antenna etc. and understand their applications.
6. Identify radio wave propagation types in wireless communication channels and understand important phenomena occurring within them

Prerequisite: 1. Vector Calculus 2. Fundamental concepts of electricity and magnetism

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Static fields**	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation, Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations, Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential.	07	CO1
		Self-Learning Topics: Vector Algebra, Co-ordinate systems. Electric Dipole & Dipole Field, Equipotential Surfaces, Magnetic Field of Solenoid, Magnetic Dipole Moment	07	
II	**Electromagnetic Field and Maxwell's Equations**	Faraday's Law, Displacement current density, Maxwell's equation for time varying field, Boundary conditions. EM wave propagation through lossy, perfect dielectric and conducting medium. Power in EM Wave: Poynting theorem and Poynting vector	08	CO2
		Self-Learning Topics: Electromagnetic Spectrum, Polarization of EM Waves, Skin Depth in Conductors, Applications of Poynting Vector	08	
	Basics of Antennas	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential. Antenna Parameters: Isotropic antenna, Radiation pattern,	08	CO3

III		radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula. Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna		
		Self-Learning Topics: Antenna Safety & Radiation Hazards, Antenna Installation & Alignment, Real-World Antenna Case Studies, Antenna Simulation Tools (Intro)	08	
IV	**Antenna Arrays**	Linear arrays of two isotropic point sources, linear arrays of N elements, Broadside and Endfire arrays, Principle of pattern multiplication. Introduction to Planar and circular arrays Introduction to array synthesis using Binomial array	07	CO4
		Self-Learning Topics: Dolph–Chebyshev Array, Phased Array & Beam Steering, Grating Lobes in Arrays	07	
V	**Types of antennas**	Yagi antenna, Broadband antenna like Helical and Log Periodic antenna. Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn. Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector. Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)	08	CO5
		Self-Learning Topics: Antennas in wireless communication systems, Antenna measurement techniques, Satellite communication antennas, Embedded antennas in mobile/IoT devices	08	
VI	**Electromagnetic Wave Propagation**	Ground, Sky, Space wave propagation. Ionospheric propagation (layers, MUF, critical frequency). Tropospheric propagation	07	CO6
		Self-Learning Topics: Fading in wireless communication, Path loss in wireless communication, Applications of propagation in communication systems	07	
	Total		90	

Text Books:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition

3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

References:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition

Online References:

Sr. No.	Website Name
1.	Electromagnetic Theory, IIT Kanpur, Prof. Pradeep Kumar nptel.ac.in/courses/108104087
2.	NPTEL : NOC:Antennas (Electrical Engineering) Antenna -Prof. Girish Kumar

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.

- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211602	Artificial Intelligence and Machine Learning	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211602	Artificial Intelligence and Machine Learning	20	20	40	60	2.5	--	--	100

Rationale:

This subject equips students with foundational and advanced concepts in Artificial intelligence and Machine learning, enabling them to model, analyse, and design intelligent systems used in modern AI applications like classification, control, and automation.

Course Objectives:

1. To introduce fundamental concepts of Artificial Intelligence and intelligent systems.
2. To develop problem-solving skills using search and knowledge representation techniques.
3. To understand AI applications in Electronics and Telecommunication domains.
4. To provide knowledge of Machine Learning concepts and data-driven modeling.
5. To apply supervised and unsupervised learning algorithms to engineering problems.
6. To familiarize students with advanced ML and deep learning techniques for real-world applications.

Course Outcomes: After successful completion of the course student will be able to

1. Explain core concepts of Artificial Intelligence and intelligent agents.
2. Apply search algorithms and knowledge representation methods to solve problems.
3. Analyze AI techniques used in communication and embedded systems.
4. Build and evaluate basic machine learning models using appropriate techniques.
5. Apply classification and clustering algorithms to real-world datasets.

6. Demonstrate understanding of deep learning concepts and their applications in engineering.

Prerequisite:

1. Basic Linear Algebra: Matrices, vectors, dot product, linear transformations.
2. Probability and Statistics: For understanding learning algorithms and model evaluation.
3. Basic Programming Knowledge: Python or MATLAB for neural network implementation.
4. Signals and Systems: Understanding of system modeling and transformations.
5. Basic Computer Science Concepts

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**AI Fundamentals & Intelligent Agents**	Introduction to AI: Definition, History, Applications, AI in Electronics & Communication (Signal Processing, IoT) Intelligent Agents: Types, Architecture, PEAS Problem Solving & State Space Representation. Uninformed Search: BFS, DFS	**07**	CO1
		Self-learning Topics: AI in 5G/6G Communication, Case Study: AI in Smart Communication Systems.	**07**	
II	**Search & Knowledge Representation**	Informed Search: Greedy, A* Algorithm. Game Playing: Minimax, Alpha-Beta Pruning. Knowledge Representation: Propositional Logic. Introduction to First-Order Logic. Rule-Based Systems	**07**	CO2
		Self-learning Topics: Expert Systems in Telecom, Introduction to Knowledge Graphs	**07**	
III	**Advanced AI Applications**	Probabilistic Reasoning (Bayesian Basics). Introduction to NLP & Speech Processing. Computer Vision Basics. Reinforcement Learning (Overview). AI in Wireless Networks & IoT	**08**	CO3
		Self-learning Topics: AI in Edge Computing, Ethical Issues in AI	**08**	
IV	**ML Fundamentals & Data Processing**	Introduction to ML & Types. ML in Signal Processing & Telecom. Data Preprocessing & Feature Extraction. Regression: Linear Regression. Model Evaluation Basics	**07**	CO4
		Self-learning Topics:	**07**	

		Telecom datasets (Kaggle/UCI), Feature engineering for sensor data		
V	**Supervised & Unsupervised Learning**	Classification: k-NN, Decision Trees. Support Vector Machines (Basics). Clustering: K-Means. Dimensionality Reduction: PCA. Applications in Network Data Analysis	**08**	CO5
		Self-learning Topics: Anomaly Detection in Networks, Spam/Signal Classification	**08**	
VI	**Advanced ML & Deep Learning**	Neural Networks Basics (Perceptron). Introduction to Deep Learning (CNN, RNN). Overfitting & Regularization. ML in Communication Systems (Speech, Image Transmission). Tools Overview: Python, Scikit-learn	**08**	CO6
		Self-learning Topics: TensorFlow/PyTorch Basics, AI in 5G Optimization	**08**	
	Total		**90**	

Text Books:

1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Harlow, UK: Pearson, 2020.

2. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2019.

3. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016.

References:

1. C. M. Bishop, *Pattern Recognition and Machine Learning*. New York, NY, USA: Springer, 2006.

2. K. P. Murphy, *Machine Learning: A Probabilistic Perspective*. Cambridge, MA, USA: MIT Press, 2012.

3. S. Shalev-Shwartz and S. Ben-David, *Understanding Machine Learning: From Theory to Algorithms*. Cambridge, UK: Cambridge University Press, 2014.

4. E. Alpaydin, *Introduction to Machine Learning*, 3rd ed. Cambridge, MA, USA: MIT Press, 2014.

5. T. M. Mitchell, *Machine Learning*. New York, NY, USA: McGraw-Hill, 1997.

Online References:

Sr. No.	Website Name
1.	Neural Networks for Computer Vision and Natural Language Processing - Course
2.	Introduction to Machine Learning - Course

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**

2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211603	Image Processing and Applications	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211603	Image Processing and Applications	20	20	40	60	2.5	--	--	100

Rationale:

The syllabus on Digital Image Processing is designed to provide students with a strong foundation in image representation, enhancement, transformation, segmentation, and analysis techniques, progressing from basic concepts to advanced methodologies. It integrates both spatial and frequency domain approaches, along with morphological and restoration methods, to develop a comprehensive understanding of image processing systems. The inclusion of representation techniques and real-world applications such as medical imaging, remote sensing, and surveillance ensures that students can connect theoretical knowledge with practical problem-solving. This structured approach equips learners with the analytical and application-oriented skills required for careers in fields like computer vision, artificial intelligence, and multimedia systems.

Course Objectives:

1. To explain digital image fundamentals, representation, color models, and basic image processing steps.
2. To describe spatial and frequency domain techniques for image enhancement and histogram modeling.
3. To explain transform-based image processing techniques including DFT, DCT, KLT, and wavelet transforms.
4. To describe image segmentation techniques including edge detection, thresholding, and region-based methods.
5. To explain morphological operations and image restoration techniques.

6. To summarize image representation techniques and real-world applications of digital image processing.

Course Outcomes:

1. Analyze digital images, differentiate color models, and perform color space conversions to explain fundamental image processing steps.
2. Apply spatial, frequency domain, and histogram-based techniques for image enhancement.
3. Analyze and implement transform techniques for image representation and processing.
4. Apply edge detection and segmentation techniques for image analysis.
5. Apply morphological processing and restoration methods for image enhancement and analysis.
6. Analyze image features and apply image processing techniques to solve real-world problems.

Prerequisite:

1. Mathematics for Signals and Systems
2. Discrete Time Signal Processing
3. Python Programming Skill Lab

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Image Fundamentals**	Introduction to Digital Images, Fundamental steps in Digital Image Processing along with the block diagram, concept of spatial and intensity resolution, Relationships between pixels, Gray-scale vs color images, Color Models & Spaces-RGB, CMY/CMYK, HSV/HSI color models, Conversion between color spaces, Image File Formats	07	CO1
		Self-learning Topics: Fundamental concepts of signals, matrices, and frequency required for understanding digital image processing. Image as a 2D signal, Frequency domain concepts. Image acquisition techniques used in a digital camera, Sampling and quantization, Structure of a 24-bit bmp color image.	07	
II	**Image Enhancement**	**Spatial Domain** **Point Processing:** Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform. **Neighborhood Processing:** Averaging filters, order statistics filters, high pass filters and high boost filters	08	CO2

		Frequency Domain: DFT for filtering, Ideal, Gaussian and Butterworth filters for smoothening and sharpening, and Homomorphic filters **Histogram Modeling:** Histogram, Histogram stretching, equalization and histogram specification		
		Self-learning Topics: Interpretation of various image attributes by plotting their histograms, Applications of filters in various domains.	08	
III	**Image Transform**	Discrete Fourier Transform, Discrete Cosine Transform, KL Transform, and Discrete Wavelet Transform, Haar transform	08	CO3
		Self-learning Topics: Fourier Transform, Color space and Transformation, Image Splitting using Wavelets, frequency spectrum of a simple image, Compare DWT vs DCT for compression efficiency	08	
IV	**Image Segmentation**	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm, **Edge linking:** edge linking using Hough transform and graph theoretic approach Thresholding: Foundation, Role of illumination and reflectance, Basic global thresholding **Region Based segmentation:** Region Growing, Region Splitting and merging.	07	CO4
		Self-learning Topics: Advanced Thresholding & Morphological Refinement, Graph-Based & Clustering Segmentation, Advanced Boundary Detection.	07	
V	**Image Morphology & Restoration**	Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction, Hole filling, Thinning and thickening Restoration: A Model of the Image Degradation/Restoration Process, Noise models, restoration using Inverse filtering and Wiener filtering.	08	CO5
		Self-learning Topics: Morphological Filtering Techniques, Skeletonization and Pruning, Advanced Restoration & Modeling	08	
VI	**Representation, Description**	Representation – Chain codes, Signatures, Boundary descriptors, Shape numbers, Fourier descriptors, regional descriptors – Topological, texture, Principal components for description, Introduction to Texture, co-occurrence matrix	07	CO6

	and Applications	Applications of digital image processing-Case study on – **Medical image analysis**-X-ray, CT scan, MRI image enhancement **Remote Sensing and Satellite Imaging**-Weather forecasting and environmental monitoring, **Security**-Surveillance and motion detection		
		Self-learning Topics: Deep learning in image processing (CNN basics), Augmented Reality (AR) and Virtual Reality (VR), Image processing in social media filters	07	
	Total		90	

Text Books:

1.Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision” Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, “Digital Image Processing”, Pearson Education, India, Third Edition,
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Inter science publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

References:

1.Anil K. Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, 1989. 2. W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002
3. Forsyth and Ponce, Computer vision: A modern approach, PHI
4. Frank Y Shish, Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010

Online References:

Sr. No.	**Website Name**
1.	Swayam Course- https://onlinecourses.nptel.ac.in/noc25_ee126/preview?utm
2.	NPTEL Course- https://onlinecourses.nptel.ac.in/noc23_cs18/preview

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212604	Electromagnetics and Antenna Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14212604	Electromagnetics and Antenna Lab	--	--	--	--	--	25	25	50

Lab Objectives:

The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Lab Outcomes:

1. Students will be able to **measure and analyze antenna parameters** such as radiation pattern, gain, directivity using instruments like FSM, Spectrum Analyzer and VNA.
2. Students will be able to **identify and compare different types of antennas** such as dipole, monopole, loop, Yagi-Uda, log-periodic, and microstrip antennas.
3. Students will be able to **analyze radiation characteristics of wire and directive antennas** through experimental observations and simulations.
4. Students will be able to study and evaluate antenna arrays (broadside, end-fire) and understand the effect of array parameters.
5. Students will be able to design and simulate antennas such as microstrip and reflector antennas using appropriate tools.
6. Students will be able to analyze radio wave propagation and practical antenna behavior in wireless communication systems.

List of Experiments

Sr No	List of Experiments	Hrs	LO
01	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)	2	LO1
02	Introduction to Different Antenna Types	2	LO2
03	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)	2	LO3
04	Study of Directive antenna, Yagi-Uda Antenna	2	LO3
05	Study of Broad-band Antenna, Log-periodic Antenna	2	LO3
06	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)	2	LO4
07	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn, with or without Reflector)	2	LO5
08	Study of Regular shaped Microstrip Antenna	2	LO5
09	Small Project report can be considered as a part of term-work (Design, Simulation and validation)	2	LO6
10	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)	2	LO6

Sr No	List of Assignment	Hrs
1	Numerical on Static Electric and Magnetic fields	01
2	Maxwell's Equations	01
3	Different Antenna parameters	01
4	Different types of Antennas	01

Assessment:

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

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212605	**Image Processing and Application Laboratory**	**--**	**--**	**2**	**--**	**--**	**30**	**--**	**30**	**1**

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14212605	**Image Processing and Application Laboratory**	**--**	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Lab Objectives:

1.To understand and implement basic image representation and color space conversion techniques using Python.
2.To apply spatial domain techniques for image enhancement.
3.To implement frequency domain transforms for image analysis.
4.To apply image segmentation techniques for extracting meaningful information.
5.To perform morphological operations and image restoration methods.
6.To analyze and implement feature extraction techniques and real-world image processing applications.

Lab Outcomes:

1.Implement image representation and perform color space conversions using Python.
2.Apply spatial domain techniques for enhancing images.
3.Analyze images using frequency domain transforms.
4.Apply segmentation techniques to extract regions of interest.
5.Implement morphological operations and restoration techniques.
6.Develop the ability to analyze image features and utilize image processing techniques to solve real-world problems.

List of Experiments:

Sr No	List of Experiments	Hours	LO Mapping
1	**Study of image representation-**Read and display grayscale and color images	2	LO1
2	**Color space conversion-**Convert RGB image to Gray, HSV, and HSI	2	LO1
3	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing	2	LO2
4	**Histogram Processing-**Plot histogram, Histogram equalization, Histogram specification (matching)	2	LO2
5	**Neighborhood Processing-**Smoothing using averaging and Gaussian filters, Median filtering (noise removal)	2	LO2
6	**Sharpening Techniques-**Laplacian filter, High-pass and high-boost filter	2	LO2
7	Frequency Domain Filtering: Ideal, Butterworth and Gaussian	2	LO3
8	Compute DFT and visualize magnitude spectrum	2	LO3
9	Apply DCT and reconstruct image.	2	LO3
10	Perform Haar wavelet decomposition and reconstruction	2	LO3
11	Implement Sobel, Prewitt, and Canny edge detectors	2	LO4
12	**Region-Based Segmentation-**Region growing,Split and merge concept (basic implementation)	2	LO4
13	**Hough Transform-Detect lines in an image**	2	LO4
14	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform	2	LO5
15	Boundary extraction-Hole filling,Thinning	2	LO5
16	Image segmentation using global Thresholding Algorithm	2	LO5
17	Implement Canny edge detection	2	LO4
18	**Boundary Representation- i)** Chain code generation ii) Shape number calculation	2	LO6
19	Feature extraction using co-occurrence matrix	2	LO6
20	Case Study on Medical image enhancement (X-ray/CT/MRI), Object detection / motion detection in surveillance, Diseases Prediction, Fingerprint identification, License plate recognition etc.	2	LO6

Sr No	List of Assignments	Hrs
01	Fundamental of image processing and Histogram numericals	01
02	Spatial domain and frequency domain	01
03	Numerical on Image Transforms	01
04	Image Segmentation	01
05	Image Morphology	01

Assessment:

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

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

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

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212606	**Dissertation -1**	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14812606	**Dissertation -1**	**--**	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Course Objective:

1. To enable students to explore the wide range of topics, give an opportunity for innovation, search for the professional literature and apply the problem-solving approaches.
2. To help students in problem formulation, setting project goals and utilization of the available resources in an optimum manner leading to innovation.
3. To develop managerial skills in students while working in a team, creative skills by demonstrating novel engineering solutions, communication skills while presenting their end application and an awareness of social and ethical ramifications of their work.
4. To teach writing a technical document and help students to represent the professional literature.

Course Outcomes:

1. Ability to acquire the thinking pattern which explores wide range of topics for innovation.
2. Ability to learn the technique of analysis, classification and then selection of appropriate literature.
3. Ability to learn to formulate a worthwhile problem statement and the methodology to apply the problem-solving approaches.
4. Ability to learn to communicate effectively with others to discuss technical, social needs and find an engineering solution. At the same time, imbibing the virtue of team-spirit.
5. Ability to develop skills for writing a technical document.
6. Ability to practicing to maintain and prepare a Project Report/ Synopsis Report of the work done as evidence of an ability to work independently and in a group for the given task.

Guidelines for Dissertation

1. Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2. Students should do survey and identify needs, which shall be converted into problem statements for project in consultation with faculty supervisor/head of department/internal committee of faculties.
3. Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of Dissertation -1 and Dissertation -II.
4. A log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5. Faculty supervisors may give inputs to students during Dissertation -1 & II activity; however, focus shall be on self-learning.
6. Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
7. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8. The solution to be validated with proper justification and report to be compiled in standard format of institute.
9. With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Dissertation, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Dissertation -1 in semester VI and Dissertation –II in semesters VII.
10. However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Dissertation adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or Copyright or Patent as an extension of the Dissertation -1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on a case-by-case basis.

Guidelines for Assessment of Dissertation:

Term Work

1. The review/ progress monitoring committee shall be constituted by Head of department of each institute. The progress of Dissertation -1 to be evaluated on a continuous basis, minimum two reviews in each semester VI and VII.
2. 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.
3. Distribution of Term work marks for both semesters shall be as below;

    . Marks awarded by guide/supervisor based on log book : 10

    . Marks awarded by review committee 10

    . Quality of Project report 05

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

One-year project:

- In semester VI entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.

- First shall be for finalization of problem and proposed solution of the problem
- Second shall be on readiness of working and testing of prototype to be conducted.

- In semester VII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.

    - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.

    - Second review shall be based on paper presentation in conference/journal or motivate for copyright or Indian patent in last month of the said semester.

Assessment criteria of Dissertation -1.

Dissertation -1 shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness

6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact

9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms

12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on the first six criteria and the remaining may be used for second semester evaluation of performance of student's project.

Guidelines for Assessment of Dissertation Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project shall be assessed through a presentation and demonstration of the 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 Scopus Conferences/Journals or copy right or Indian Patent.

Dissertation -1 shall be assessed based on following points;

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

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142216701	Computer Organisation and Architecture	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142216701	Computer Organisation and Architecture	20	20	40	60	2.5	--	--	100

Rationale:

Computer Organization and Architecture provide an understanding of the internal structure and functioning of computer systems. It explains how hardware components like CPU, memory, and I/O devices interact to execute programs. The subject helps in analyzing system performance and designing efficient computing systems. It forms a foundation for advanced topics like operating systems, embedded systems, and computer design.

Course Objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To understand memory systems, processor organization and generation of control unit signals.
3. To demonstrate the operation of various arithmetic algorithms including integer and floating-point representation.
4. To understand the working principles of multiprocessor and parallel organizations as advanced computer architectures.

Course Outcomes:

1. **Explain** the concepts of computer organization, computer architecture, system performance, multicore processors, and performance evaluation techniques.

2. **Analyze** computer system components, functional units, interconnection structures, and bus organization used in computer systems.
3. **Demonstrate** data representation methods and perform arithmetic operations using multiplication and division algorithms for integer and floating-point numbers.
4. **Classify and evaluate** different memory systems, cache organization, virtual memory, and memory hierarchy techniques in computer architecture.
5. **Illustrate** processor control operations and compare hardwired and microprogrammed control unit designs
6. **Interpret** the principles of parallel architecture, multiprocessor systems, multicore computers, and advanced computer organization techniques.

Prerequisite:

1. Digital System Design
2. Microcontrollers

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Computer Organization, Architecture and Performance**	Organization and Architecture, Structure and Function, Designing for Performance, Multicore, MICs, and GPGPUs, Two Laws that Provide Insight: Amdahl's Law and Little's Law, Basic Measures of Computer Performance, Calculating the Mean, Benchmarks and SPEC	**08**	CO1
		Self-learning Topics: Evolution of computer systems, RISC vs CISC architecture, Performance comparison of multicore processors, Study of modern GPUs and accelerators, Case study on benchmarking tools and SPEC standards	**08**	
II	**Computer System**	Computer Components, Computer Function Interconnection Structures, Bus Interconnection	**07**	CO2
		Self-learning Topics: Types of buses, Bus arbitration techniques, I/O interfacing methods, PCI and USB standards, Study of system interconnection networks	**07**	
III	**Data Representation and Arithmetic Algorithms**	Unsigned & Signed multiplication- Add & Shift Method, Booth's algorithm. Unsigned & Signed division, Restoring and non-restoring division. Integer and floating-point representation, IEEE 754 standard for floating point (Single & double precision) number representation.	**08**	CO3
		Self-learning Topics: Binary coded representations, Excess-3 and gray codes, Arithmetic logic unit design, Floating point arithmetic examples, Error detection methods in arithmetic operations.	**08**	

IV	**Memory System Organization**	Classification and design parameters, Memory Hierarchy, Internal Memory: RAM, SRAM and DRAM. Cache Memory: Characteristics of Memory Systems, Cache Memory Principles, Elements of Cache, Cache Coherence. Design problems based on mapping techniques. Virtual Memory, External Memory: Magnetic Discs, Solid State Drive, Optical Memory, Flash Memories, RAID Levels.	**07**	CO4
		Self-learning Topics: Associative memory, Cache replacement policies, Memory management techniques, Study of SSD architecture, RAID implementation case studies.	**07**	
V	**Control Unit Design**	Micro- Operations: The Fetch Cycle, The Indirect Cycle, The Interrupt Cycle, The Execute cycle, The Instruction Cycle Control of the Processor: Functional Requirements, Control Signals, Internal Processor Organization. Hardwired Control Unit. Microinstructions Microprogrammed Control Unit, Advantages & disadvantages	**08**	CO5
		Self-learning Topics: Instruction pipelining basics, RISC control organization, Advanced microprogramming concepts, Pipeline hazards and solutions, Study of modern processor control mechanisms	**08**	
VI	**Fundamentals of Advanced Computer Architecture**	Parallel Architecture: Classification of Parallel Systems, Flynn's Taxonomy, Array Processors, Clusters, and NUMA Computers. Multiprocessor Systems: Structure & Interconnection Networks, Multi-Core Computers: Introduction, Organization and Performance.	**07**	CO6
		Self-learning Topics: SIMD and MIMD systems, GPU architecture basics, Distributed computing concepts, Cloud computing architecture, Case studies of multicore processors	**07**	
	Total		90	

Text Books:

1. William Stallings "Computer Organization and Architecture Designing for Performance" Tenth Edition, Pearson Education.

2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGrawHill,

3. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition

References:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design -

2. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007

3. J.P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998

4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO’s and **IAT-II** will cover the remaining three CO’s (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom’s Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142216702	Database Management System	3	--	–	45	--	–	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT -I	IAT-II	Total					
142216702	Database Management System	20	20	40	60	2.5	–	–	100

Rationale:

The syllabus is designed to build a strong foundation and progressive understanding of **Database Management System**, aligning with current industry demands and emerging technologies.

Course Objectives:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4. Understand the concept of database security and privacy

Course Outcomes:

1. Describe the fundamentals of database systems.
2. Describe different data models
3. Design ER diagram, relational schemas, and discuss design issues in database.
4. Understand the basics model of relational Algebra, calculus, apply concepts of normalization to relational database design.
5. Implement views, triggers and querying the database using SQL.
6. Understand transaction management, concurrency control, database security and privacy.

Prerequisite:

C Programming
C++ and Java Programming
Python Programming

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Databases**	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, Three tier database architecture, Data independence	07	CO1
		Self-learning Topics: Study an example database application: a banking enterprise consisting of multiple bank branches. Suggested Case Studies: Library Management System, Hospital Management System, Students Database Management System, Employee Management System	07	
II	**Data Models**	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction.	07	CO2
		Self-learning Topics: Apply and compare different models for the banking enterprise application or any of the suggested case studies	07	
III	**Database Design, ER-Diagram and Unified Modeling Language**	Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets. Codd ‘s rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	08	CO3
		Self-learning Topics: Prepare ER model for banking Enterprise application. Draw ER diagrams, denote weak and strong entity sets. Design relational databases for this application or any of the suggested case studies**.**	08	

IV	**Relational Algebra and Calculus**	Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	08	CO4
		Self-learning Topics: Apply relational algebra to the relational databases of banking enterprise applications or any of the suggested case studies and normalize the database till BCNF.	08	
V	**Constraints, Views and SQL**	What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views. ** SQL Tools: MySQL, ORACLE 10G, POSTGRESQL	08	CO5
		Self-learning Topics: For banking enterprise application or any of the suggested case studies. 1. Using any of the SQL tool mentioned, create database using data definition language. 2. Apply various aggregate functions, data manipulation language to update database. 3. Apply query, nested sub query for various calculations on database. 4. Define views and apply trigger to the databases.	08	
VI	**Transaction management and Concurrency control**	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy: Issues, Access Control based on grant and revoke privileges	07	CO6
		Self-learning Topics: Study deadlock, recovery management, access control for banking enterprise application or any of the suggested case studies	07	
	Total		90	

**** Teacher can select any one SQL Tool for implementation of SQL query**

Text Books:

1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts‖", Fifth Edition McGraw-Hill
2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System‖", Seventh Edition, Person.
4. G. K. Gupta, "Database Management Systems‖", McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley
4. Raghu Ram krishnan and Johannes Gehrke, "Database Management Systems", TMH
5. Debabrata Sahoo "Database Management Systems‖ Tata McGraw Hill, Schaum 's Outline

Online References:

Sr. No.	Website Name
1.	Course: Data Base Management System, By Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc26_cs39
2.	Course: Introduction to Database Systems By Prof. Sreenivasa Kumar, IIT Madras https://onlinecourses.nptel.ac.in/noc26_cs72
3	Course: Data Base Management System By Dr.E. Shanmuga Priya, Assistant Professor **https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cs08**

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**

- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142216703	IOT Industry 4.0	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142216703	IOT Industry 4.0	20	20	40	60	2.5	--	--	100

Rationale:

This course provides fundamental and advanced knowledge of IoT, IIoT, and Industry 4.0 technologies used in modern smart systems and industries. It helps students understand IoT architecture, communication protocols, device integration, and real-time connectivity.

The course develops skills in data management, cloud computing, analytics, and automation tools for intelligent applications. It introduces Industry 4.0 concepts such as cyber-physical systems, AI, smart manufacturing, and industrial automation. Students gain knowledge of industrial applications in healthcare, power plants, inventory management, and facility management. The course prepares learners for emerging technologies like Industry 5.0, human–machine interaction, cybersecurity, and AI-based industrial solutions.

Course Objectives:

1. To offer introduction to Internet of Things and industry 4.0 standard
2. To understand the design features of Internet of Things (IOT)
3. To understand concepts of data management and data analytics in IoT
4. To understand the concept and framework of industry 4.0 standard

5. To understand the application of IoT and Industry 4.0 Standard

Course Outcomes:

1. Discuss case studies and use cases of IoT design
2. Illustrate various protocols of web connectivity
3. Understand and use tools for data management and analytics in IoT
4. Explain various frameworks for industry 4.0 standards
5. Prepare case studies on application of IIoT
6. Understand advanced concepts and applications of industry 4.0

Prerequisite:

Microcontrollers

Embedded System

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to IoT**	Introduction - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, IoT and M2M - IoT/M2M System layers and Design standardization, Difference between IoT and M2M. Defining Specifications About - Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study.	7	CO1
		Self-learning Topics: Students can study smart home IoT systems, IoT and M2M communication, and the use of sensors, actuators, and embedded devices in real-world applications. They can explore IoT functional blocks, communication standards, system layers, and design simple IoT models for healthcare, agriculture, or smart cities. Self-learning may also include IoT application development concepts such as domain models, operational views, device integration, and case studies on practical IoT implementations.	7	
		Design Principles & Web Connectivity - Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish —Subscribe), MQTT, AMQP, CoAP Protocols. Internet Connectivity: - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN	7	CO2

II	**Network & Communication aspects**	Fundamentals: LORA, NBIoT, CAT LTE Ml, SIGFOX, Case Study		
		Self-learning Topics: Students can explore web communication protocols such as HTTP, REST, MQTT, CoAP, AMQP, and Web Sockets used in IoT systems, along with gateway-based connectivity and Internet communication mechanisms. They can also study IP addressing, MAC protocols, LPWAN technologies like LoRa, NB-IoT, LTE Cat-M1, and Sigfox, and analyze real-world IoT communication case studies.	7	
III	**Data Management and Analytics for IoT**	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis. Analysis, Structural Health Monitoring Case Study, Tools for IoT: - Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator	8	CO3
		Self-learning Topics: Students can explore big data and real-time analytics tools such as Apache Hadoop, MapReduce, Spark, Storm, and Oozie for processing IoT-generated data efficiently. They can also study IoT management tools like Chef, Puppet, NETCONF-YANG, and analyze structural health monitoring and multi-tier deployment case studies.	8	
IV	**Introduction to Industry 4.0**	Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT- Layers, Sensing, Processing, Communication. Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	8	CO4
		Self-learning Topics: Students can explore the concepts of Industry 4.0, digital transformation, IIoT architecture, sensing, processing, and communication technologies used in smart industries. They can also study cyber-physical systems, next-generation sensors, product lifecycle management, and the applications of augmented reality and virtual reality in industrial environments.	8	

V	**Introduction to Industrial IoT (IIoT)**	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management. Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	7	CO5
		Self-learning Topics: Students can explore Industrial IoT applications in healthcare, power plants, inventory management, quality control, plant safety, security, and facility management through real-world examples and case studies. They can also study the role of artificial intelligence, cybersecurity, IoT-based industrial design, and the major challenges and solutions in Industry 4.0 environments.	7	
VI	**Industry 4.0 Technologies and Applications**	Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	8	CO6
		Self-learning Topics: Students can explore how IoT creates value across different industries along with key barriers such as standards, security, and privacy concerns affecting its adoption. They can also study Industry 5.0 concepts including human–machine interaction, cognitive computing, and AI-based case studies demonstrating intelligent system solutions.	8	
	Total		90	

Text Books:

1. Arshdeep Bahga 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
3. Radha Shankarmani, M Vijayalakshmi,” Big Data Analytics”, Wiley Publications,
4. Andrew Minteer,” Analytics for the Internet of Things (IoT)”, Kindle Edition
5. Giacomo Veneri, Antonio Capasso,” Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0”, Packt

References:

1. Alp Ustundag Emre Cevikcan,” Industry 4.0: Managing The Digital Transformation”,

Springer Series in Advanced Manufacturing
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing
3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
4. The Internet of Things (MIT Press) by Samuel Greengard
5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2.	https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3.	https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4.	https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design By Prof. Anupam Basu, IIT Kharagpur
5.	Node Red - https://nodered.org/
6.	M2MLabs Mainspring - http://www.m2mlabs.com/
7.	Tensor Flow - https://www.tensorflow.org/
8.	Things Speak - https://thingspeak.com/

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.

- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
142216704	Mixed Signal VLSI	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
142216704	Mixed Signal VLSI	20	20	40	60	2.5	--	--	100

Rationale:
This course provides fundamental and advanced knowledge of analog CMOS integrated circuit design, which is essential for modern VLSI systems and mixed-signal applications. The course covers IC biasing techniques, MOS amplifiers, noise analysis, operational amplifiers, and data converter architectures that form the backbone of contemporary electronic systems such as communication devices, biomedical instruments, embedded systems, and IoT applications. Emphasis is given to CMOS analog design methodologies, performance analysis, and SPICE-based simulation techniques to bridge theoretical concepts with practical VLSI design implementation.

Course Objectives: Understand various building services systems.

1. To understand integrated circuit biasing techniques and current reference circuits used in CMOS analog design.
2. To analyze and design single stage MOS amplifiers and differential amplifiers using CMOS technology.
3. To study different noise mechanisms in MOS circuits and their impact on analog circuit performance.

4. To understand the design and compensation techniques of CMOS operational amplifiers.
5. To learn the fundamentals of data conversion and mixed signal design considerations.
6. To analyze and compare various ADC and DAC architectures used in modern VLSI systems.

Course Outcomes:

1. Explain integrated circuit biasing techniques, current mirrors, and reference generation circuits used in analog CMOS design.
2. Analyze and design single stage MOS amplifiers and differential amplifier configurations using CMOS technology and SPICE simulation.
3. Identify and evaluate different noise sources and noise performance parameters in MOS circuits.
4. Design CMOS operational amplifiers and apply compensation techniques for stable analog circuit operation.
5. Describe data converter fundamentals, sampling concepts, and mixed signal layout considerations
6. Compare and analyze different ADC and DAC architectures for data conversion applications.

Prerequisite:

1. Electronic Devices and Circuits
2. Digital VLSI
3. Digital System Design
4. Linear Integrated Circuits

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Integrated Circuit Biasing Techniques**	Active resistance, current source, current sink, simple current mirror, cascode current mirror. Current and voltage references, Band gap reference generator.	07	CO1
		Self-learning Topics: Introduction of MOSFET operation, Analog Electronics, Current Mirrors, Differential Amplifiers, Basics of Operational Amplifiers. Advanced current reference circuits, Low power biasing techniques, Applications of bandgap references in modern ICs.	07	
II	**Single Stage MOS 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 cascode stage, simulation of CMOS amplifiers using SPICE. Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE.	07	CO2

		Self-learning Topics: Performance comparison of amplifier topologies, Recent CMOS amplifier architectures, Introduction to low-voltage analog design techniques.	07	
III	**Noise in MOS Circuits**	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise. Representation of noise in circuits, noise in single stage CS, CD and CG amplifier. Noise in differential pairs, noise bandwidth.	07	CO3
		Self-learning Topics: Noise reduction techniques in CMOS circuits, Low-noise amplifier applications, Case studies on noise optimization in analog ICs.	07	
IV	**CMOS Operational Amplifier**	Design of Current Mirror Load Differential Amplifier. Design of two stage Operational Transconductance Amplifier, OpAmp compensation techniques.	08	CO4
		Self-learning Topics: Advanced Op-Amp architectures, Frequency compensation methods, Applications of OTA in analog integrated circuits.	08	
V	**Data Converter Fundamentals**	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics. Mixed signal layout issues, floor planning, power supply and ground issues, other interconnect considerations.	08	CO5
		Self-learning Topics: Sampling theorem applications, Mixed signal IC design challenges, PCB layout considerations for analog and digital systems.	08	
VI	**Data Converter Architectures**	DAC architectures, digital input code, charge scaling DACs, cyclic DAC, pipeline DAC. ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC.	08	CO6
		Self-learning Topics: High-speed and high-resolution data converters, Applications of ADC/DAC in communication systems, Comparative study of ADC architectures.	08	
	Total		90	

Text Books:

1. Design of Analog CMOS Integrated Circuits, B. Razavi, First Edition, McGraw Hill, 2001.
2. CMOS Analog Circuit Design, Second Edition, Oxford University Press, 2002.

3. CMOS Circuit Design, Layout and Simulation, Third Edition, Wiley-IEEE Press, 2013.

References:

1. Microelectronic Circuits, Oxford University Press.
2. Analysis and Design of Analog Integrated Circuits, Fourth Edition, Wiley International, 2002.
3. Design of CMOS Analog Integrated Circuits, McGraw Hill Education.

Online References:

Sr. No.	Website Name
1.	NPTEL: Analog Integrated Circuits

Summary of Internal Assessment (IA) and End Semester Examination (ESE)

Internal Assessment (IA) – 40 Marks

- Two compulsory Internal Assessment Tests (IATs) of **20 marks each** will be conducted.
- **IAT-I** will cover three CO's and **IAT-II** will cover the remaining three CO's (Course Outcomes).
- Duration of each test: **1 hour**.
- The **summation of both tests** will be considered for IA marks.

End Semester Examination (ESE) – 60 Marks

- Duration: **2 Hours 30 Minutes**
- Question paper consists of **six compulsory questions**, **10 marks each**.
- Questions will be set module-wise: Q1 – Module I, Q2 – Module II, Q3 – Module III and so on...
- Each question may have **two alternatives (Option A / Option B)** from the same module.
- Both options should be of **similar difficulty level** and assess similar learning outcomes.
- Internal choice may be provided within questions.
- Questions should cover the **entire syllabus**, all Course Outcomes, and different levels of learning as per **Bloom's Taxonomy**.

Note: -

1. **Internal Assessment (IA) – 40 Marks + End Semester Examination (ESE) – 60 Marks = Total – 100 Marks**
2. **No questions shall be asked from self-learning modules in either the Internal Assessment or the End Semester Examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98412609	**Professional Communication and Ethics** - II	**2**	**--**	**--**	**30**	**--**	**--**	**30**	**60**	**2**

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
98412609	**Professional Communication and Ethics -II**	--	--	--	--	--	25	--	25

Rationale:

The syllabus is designed to help students face the corporate requirement with respect to interpersonal skills, resume drafting, presentation giving and to crack the interviews.

Course Objectives:

1. To develop students interpersonal and professional communication skills.
2. To train in group discussion techniques and collaborative communication for selection processes and teamwork.
3. To prepare effective resumes and perform confidently in interviews.
4. To train students to answer confidently and cracked HR interview.
5. To build competence in drafting notices, agendas and minutes of the meetings.
6. To enhance the ability to deliver structured presentations and prepare professional reports.

Course Outcomes:

1. Demonstrate effective communication skills, including clarity, confidence, and appropriate body language in professional settings.
2. Participate actively in group discussions by presenting ideas logically, listening effectively, and demonstrating leadership and teamwork.
3. Prepare well-structured resumes aligned with industry standards and customize them for specific job profiles.
4. Perform effectively in interviews by answering HR and behavioral questions using structured techniques like the STAR method.
5. Draft formal business documents such as notices, agendas, and minutes of meetings with proper format and professionalism.
6. Deliver effective presentations and prepare structured reports with clarity, coherence,

and appropriate visual aids.

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Interpersonal Skills**	Definition, importance, and scope of interpersonal skills, Components of interpersonal skills: Emotional Intelligence (self-awareness, self-regulation, motivation, empathy, social skills), Leadership and teamwork concepts, Communication in teams: barriers and effectiveness, Empathy and assertiveness: meaning and significance, Conflict management: types, causes, and resolution strategies.	05	CO1
		Self-Learning Topics: Self-assessment of interpersonal skills via SWOT analysis.	05	
II	**Group Discussion**	Purpose of Group Discussion in recruitment and teamwork, Types of GD: Topic-based, case-based, abstract, activity-based, technical vs non-technical GD, Structure of GD: initiation, discussion flow, conclusion, Evaluation parameters: clarity, content, communication skills, leadership, GD etiquette: turn taking, listening, body language, summarizing, Do's and Don'ts in GD.	05	CO2
		Self-Learning Topics: Latest GD topics via (Current affairs, social issues, technology)	05	
III	**Resume building**	Purpose and importance of resume and CV, Types of resumes: chronological, functional, combination, Key sections of a resume: Objective/Summary, Education, Skills, Projects and achievements, Principles of effective resume writing: clarity, conciseness, relevance, Resume customization for different job roles.	05	CO3
		Self-Learning Topics: Industry specific resume formats (IT, Core, Engineering, Managements).	05	
IV		Meaning and types of interviews (HR, technical, behavioral), Common HR interview questions and expected responses, STAR method for answering behavioral questions, Interview	05	CO4

	HR / Personal Interviews	etiquette: dress code, body language, communication style, Handling stress questions and tricky situations, Basic interview preparation strategies.		
		Self-Learning Topics: Frequently asked HR and behavioral interview questions.	05	
V	**Notice, Agenda and Meeting**	Features of formal English: tone, clarity, precision, Types of notices: circulars, warnings, announcements, Format and structure of notices, Agenda of meetings: meaning, elements, and format, Minutes of meetings: purpose, structure, and recording decisions, Importance of professional documentation.	05	CO5
		Self-Learning Topics: Study of real meeting, agendas and minutes (Corporate samples).	05	
VI	**General Topic Presentation & Report Making**	Principles of effective presentations, Structure of presentation: introduction, body, conclusion, Audience analysis and communication objectives, Presentation techniques: voice modulation, pacing, transitions, Slide design principles: simplicity, bullet points, visual clarity	05	CO6
		Self-Learning Topics: Learning Different types of reports (Technical, survey, analytical)	05	
	Total		60	

Sr. No.	**Documents required to be submitted for internal orals:**
1.	Reflection report on GD.
2.	Resume drafted in latest format.
3.	Corporate meeting – Frame Notice, Agenda, and minutes of the meeting.
4.	Short report format and a case study for the same.

References:

1. Communication Skill for Engineers & Scientists (2nd Edition) by Sangeeta Sharma & Mohan N. Mishra.
2. Art of Effective communication in group discussion and interview by O. P. Singh.

Online Resources:

Sr. No.	Website Name
1.	LPU Blog: Comprehensive GD guide with techniques, frameworks, phrases, do's/don'ts, and topic types (campus to corporate): https://www.lpu.in/blog/from-campus-to-corporate-the-ultimate-guide-to-master group-discussion/
2.	Tech Interview Handbook: ATS-friendly resume guide for software engineers (templates, keywords, structure, tools): https://www.techinterviewhandbook.org/resume/

Assessment:

Internal Assessment:
Term work marks – (Total 25 marks)
Group Discussion - 10 marks
Mock PI - 5 marks
Mock Meeting and Roleplay -5 marks
Attendance - 5 marks