AC No. 03/2026
Item No. 03

The Bombay Salesian Society's

Don Bosco Institute of Technology,Mumbai

(An Autonomous Institute Affiliated to the University of Mumbai)

CURRICULUM STRUCTURE FOR THIRD YEAR ENGINEERING

SEMESTER V

Department of Electronics and Telecommunication Engineering

(As per NEP 2020)

(Scheme: DB25-V1)

Effective from Academic Year 2026-2027

1. Preamble

Don Bosco Institute of Technology, Kurla, Mumbai, proudly celebrates the achievement of autonomous status—an academic milestone that reaffirms our steadfast commitment to excellence, holistic development, and student-centric learning. This autonomy empowers us to craft and implement a curriculum that is forward-looking, contextually relevant, and deeply rooted in our institutional values and the aspirations of our nation.

As an autonomous institution affiliated with the University of Mumbai, DBIT embraces the opportunity to restructure its academic framework in alignment with the University Grants Commission (UGC) guidelines and the National Education Policy (NEP) 2020. This curriculum framework outlines the undergraduate engineering programs for the EXTC, COMP, IT, and MECH branches. It reflects NEP's emphasis on multidisciplinary learning, flexibility, and outcome-based education, while staying true to the Don Bosco educational philosophy.

The curriculum adopts a top-down approach, beginning with the institutional Vision and Mission, which guides the definition of Program Educational Objectives (PEOs) and Program Outcomes (POs). These outcomes are used to shape Course Outcomes (COs) and the content and assessment methods of each course. This ensures that all academic efforts remain aligned with the broader goals of transforming learners into technically sound, ethically responsible, and socially aware citizens. Importantly, this curriculum has been shaped through extensive consultations with stakeholders, including industry experts, academic peers, alumni, and students—to ensure that it remains aligned with contemporary industry requirements and societal expectations. Their inputs have been instrumental in designing a framework that bridges the gap between academic learning and practical applicability.

Key Objectives in developing syllabus are:

1. **Develop Strong Technical Foundations:** Equip students with robust knowledge and skills in core engineering domains to solve real-world problems through design, analysis, and innovation.
2. **Foster Research, Innovation, and Entrepreneurship:** Cultivate a spirit of inquiry, critical thinking, and entrepreneurial mindset to promote research-based problem-solving and startup culture.
3. **Enhance Interdisciplinary and Industry-Ready Competencies:** Integrate emerging technologies, multidisciplinary learning, and practical exposure to prepare students for dynamic industry requirements and lifelong learning.
4. **Promote Ethical, Sustainable, and Socially Responsible Engineering Practice:** Inculcate ethics, human values, and environmental consciousness to enable students to contribute meaningfully to society and sustainable development.
5. **Empower Communication, Leadership, and Teamwork Abilities:** Strengthen students' soft skills, collaboration, and leadership to perform effectively in diverse professional and global environments.

Academic design includes:

- A Choice-Based Credit System (CBCS) for flexibility
- A range of Minor and Honors options to encourage specialization and research
- Opportunities for field engagement, internships, and experiential learning
- Emphasis on skill enhancement and future workforce needs
- Integration of ethical reasoning, social awareness, and environmental consciousness

As an institution inspired by the values of Saint John Bosco, we strive to create a joyful and inclusive learning environment that fosters creativity, curiosity, and compassion. Through this curriculum framework, we reaffirm our commitment to producing graduates who are not only professionally competent but also dedicated to the greater good of society.

2. Vision and Mission

Vision:

DBIT will be recognized for providing an innovative, enjoyable, and holistic learning environment that transforms individuals into socially conscious citizens, the Don Bosco way, and will lead in research and entrepreneurship in the field of sustainable technologies.

Mission:

1. To create future engineers who work with honesty and integrity and excel in the use of technology for the benefit of the underprivileged.
2. To train engineers to be innovative problem-solvers and entrepreneurs who engage in research and lifelong learning.
3. To provide a diverse and stimulating environment for staff and students to grow holistically.

3. Curriculum Design Philosophy

The curriculum is structured in alignment with the National Education Policy (NEP) 2020 and UGC guidelines. It follows a top-down approach, wherein the institutional Vision and Mission guide the Program Educational Objectives (PEOs) and Program Outcomes (POs). These shape the Course Outcomes (COs) and form the foundation for the course structure, delivery, and assessments.

Key design principles include:

- Emphasis on Outcome-Based Education (OBE) with clear mappings of COs to POs
- Integration of core technical knowledge with interdisciplinary electives
- Inclusion of vocational skills, internships, and community engagement
- Development of entrepreneurship and research aptitude through minor and honors pathways
- Encouragement of ethical, sustainable, and socially responsible engineering practices

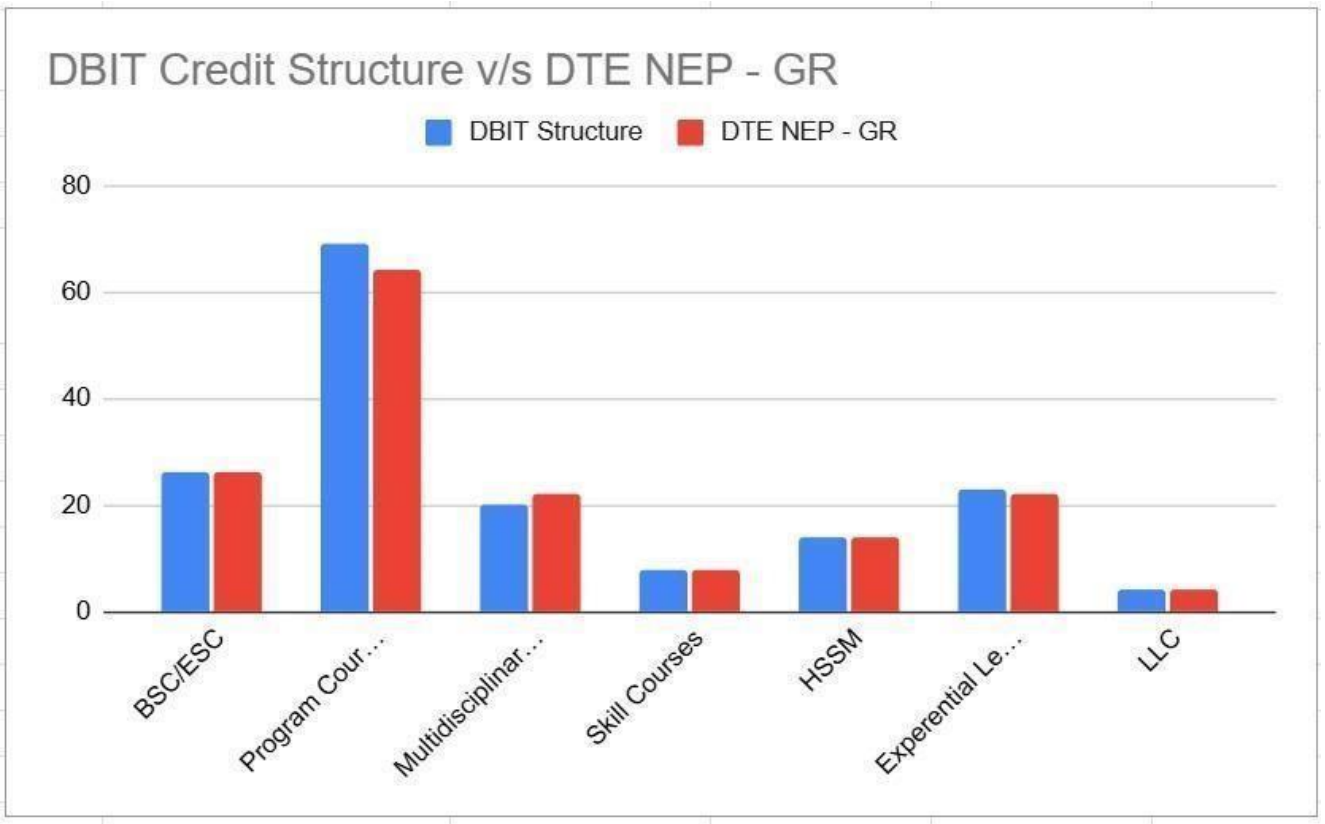
4. Credit Guidelines and Allocation

The curriculum is delivered through a structured credit system as follows:

Activity Type	Credit Definition
Theory Course	1 Credit = 15 Contact Hours
Laboratory / Studio / Workshop	1 Credit = 30 Contact Hours
Internship / Field Work	1 Credit = 40 Hours or 02 weeks
Seminar / Group Discussions	1 Credit = 15 Hours
Community Engagement / Field Project	1 Credit = 30 Hours

DBIT Overall Curriculum Credit Structure:

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits	DTE Credits
Basic Science Course	BSC/ESC	9	6							15	14-18
Engineering Science Course		7	4							11	12 - 16
Programme Core Course (PCC)	Program Courses		3	16	14	8	8	7		56	44-56
Programme Elective Course (PEC)						3	3	6	6	18	20
Multidisciplinary Minor (MDM)	Multidisciplinary Courses				3	4	4	3		14	14
Open Elective (OE) Other than a particular program						2	2	2		6	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	3	3	2						8	8
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)		2			2				4	4
Entrepreneurship/Economics/ Management Courses					2		2			4	4
Indian Knowledge System (IKS)			2							2	2
Value Education Course (VEC)				2						4	4
Research Methodology	Experiential Learning Courses					2				2	4
Community. Engagement. Project (CEP)/ Field Project (FP) (Mini - Project)				1	1	1				3	2
Project							3	3		6	4
Internship/ OJT									12	12	12
Co-curricular Courses (CC)	Liberal Learning Courses		1		1		1		1	4	4
Total Credits (Major)		21	21	21	21	22	23	21	19	169	160 - 176



5. Degree Options and Exit Pathways

Students are offered flexible learning pathways through the following options:

Undergraduate Degree Options:

- B.E. - 169 credits
- B.E. Minor/Honors - 187 credits
- B.E. Honors with Research - 187 credits

Multiple Entry-Exit Options (Aligned with NEP 2020):

Exit Options	Credits Structure
Certificate after Year 1:	42 Credits + 08 credits (04 credit Exit course + 04 Summer internship).
Diploma after Year 2:	84 credits + 08 credits (04 credit Exit course + 04 Summer internship).
B. Vocational Degree after Year 3:	125 credits + + 08 credits (04 credit Exit course + 04 Summer internship).

Credits earned are banked in the **Academic Bank of Credits (ABC)** for lifelong learning flexibility.

Abbreviations Used:

AEC	Ability Enhancement Course
AEL	Ability Enhancement Laboratory
BSC	Basic Science Course
BSL	Basic Science Laboratory
CEP	Community Engagement Project
CC	Co-curricular Courses
CIE	Continuous Internal Evaluation
EEM	Entrepreneurship, Economics and Management
ELC	Experiential Learning Courses
ESC	Engineering Science Course
ESE	End Semester Examination
ESL	Engineering Science Laboratory
FP	Field Project
HSSM	Humanities Social Science and Management
IKS	Indian Knowledge System
L	Lecture
LLC	Liberal Learning Courses
MDM	Multidisciplinary Minor
MSE	Mid Semester Exam
OE	Open Elective
OJT	On Job Training
P	Practical
PCC	Program Core Course
PCL	Program Core Laboratory
PEC	Program Elective Course
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course

UG Third Year EXTC Engineering Program

Semester wise Curriculum Structure

Curriculum Scheme and Structure: Semester V									
Course Code	**Course Vertical**	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
			L	**P**	**T**	**L**	**P**	**T**	**TOTAL**
25ET5PCC01	PCC	Data Communication and Networking	3	2	-	3	1	-	4
25ET5PCC02	PCC	Communication Data Analytics	3	2	-	3	1	-	4
25ET5PCE01	PEC	Program Elective 01 #	2	2	-	2	1	-	3
25XX5MDMYY	MDM	Multidisciplinary Minor 02@	3	2	-	3	1	-	4
25IL5OEXX	OE	Open Elective 01*	2	-	-	2	-	-	2
25ET5AEC02	AEC	Professional Communication Skills	-	2*2	-	-	2	-	2
25ET5ELC	ELC	Research Methodology	2	-	-	2	-	-	2
25ET5CEP03	CEP	Community Engagement Project 3	-	2	-	-	1	-	1
		Total	**15**	**14**	**-**	**15**	**7**	**-**	**22**

@ List of MDM courses is attached as annexure. *** For Open Elective Courses, online NPTEL courses approved by Institute**

Examination and Assessment Structure

Examination Marking Scheme: Semester V								
Course Code	**Course Vertical**	**Course Name**	**Examination Marks**					
			CA	**MSE**	**ESE**	**TW**	**OR**	**OR & PR**	**Total**
25ET5PCC01	PCC	Data Communication and Networking	20	30	50	25	-	25	150
25ET5PCC02	PCC	Communication Data Analytics	20	30	50	25	-	25	150
25ET5PCE01	PEC	Program Elective 01 #	20	30	50	25	25	-	150
25XX5MDMYY	MDM	Multidisciplinary Minor 02@	20	30	50	25	-	-	125
25IL5OEXX	OE	Open Elective 01*	20	-	30	-	-	-	50
25ET5AEC02	AEC	Professional Communication Skills	-	-	-	50	-	-	50
25ET5ELC	ELC	Research Methodology	-	-	-	50	-	-	50
25ET5CEP03	CEP	Community Engagement Project 3	-	-	-	25	-	25	50
		TOTAL	**100**	**120**	**230**	**225**	**25**	**75**	**775**

Curriculum Scheme and Structure: Semester VI									
Course Code	**Course Vertical**	**Course Name**	**Teaching Scheme (Contact Hours)**			**Credits Assigned**			
			L	**P**	**T**	**L**	**P**	**T**	**TOTAL**
25ET6PCC01	PCC	Wireless and Mobile Communication	3	2	-	3	1	-	4
25ET6PCC02	PCC	IoT System Design	3	2	-	3	1	-	4
25ET6PCE02	PEC	Program Elective 02#	2	2	-	2	1		3
25XX6MDMYY	MDM	Multidisciplinary Minor 03@	3	2	-	3	1	-	4
25IL6OEXX	OE	Open Elective 02*	2	-	-	2	-	-	2
25ET6HSSM02	HSSM	Entrepreneurship/ Economics/Management Courses	2	-	-	2	-	-	2
25ET6ELC01	ELC	Major Project 1	-	6	-	-	3	-	3
25ET6LLC02	LLC	Liberal Learning Courses*	-	2	-	-	1	-	1
		Total	**15**	**16**	**-**	**18**	**5**	**-**	**23**

@ List of MDM courses is attached. **# List of Program Elective Courses is attached.** *** List of Liberal Learning Courses is attached.**

Examination and Assessment Structure

Examination Marking Scheme: Semester VI									
Course Code	**Course Vertical**	**Course Name**	**Examination Marks**						
			CA	**MSE**	**ESE**	**TW**	**OR**	**PR**	**Total**
25ET6PCC01	PCC	Wireless and Mobile Communication	20	30	50	25	-	25	150
25ET6PCC02	PCC	IoT System Design	20	30	50	25	-	25	150
25ET6PCE02	PEC	Program Elective 02#	20	30	50	25	25	-	150
25XX6MDMYY	MDM	Multidisciplinary Minor 03@	20	30	50	25	-	-	150
25IL6OEXX	OE	Open Elective 02*	20	-	30	-	-	-	50
25ET6HSSM02	HSSM	Entrepreneurship/ Economics/Management Course	50	-	-	-	-	-	50
25ET6ELC01	ELC	Major Project 1	-	-	-	25	-	25	50
25ET6LLC02	LLC	Liberal Learning Course*	-	-	-	50		-	50
		TOTAL	**150**	**120**	**230**	**175**	**25**	**75**	**775**

List of Program Electives Offered: Semester V

Sr. No.	Course Code	Course Name
01	25ET5PEC01	Cryptography and Network Security
02	25ET5PEC02	Advanced Communication System
03	25ET5PEC03	RTL Design and Functional Verification

List of Multidisciplinary Courses offered: Semester V

Sr. No.	Course Code	Course Name
01	25CE5MDM01	Android App Development
02	25IT5MDM01	Database Management System
03	25ME5MDM01	Quality Engineering
04	25ME5MDM02	Industrial Automation

List of Open Electives offered: Semester V

Sr. No.	Course Code	Course Name
01	25IL5OE01	Energy Economics and Policy
02	25IL5OE02	Ethics in Engineering Practice
03	25IL5OE03	Intellectual Property, Rights and Competition Law
04	25IL5OE04	Principle of Human Resource Management
05	25IL5OE05	Patent Search for Engineers and Lawyers
06	25IL5OE06	Developing Soft Skills and Personality
07	25IL5OE07	Soft Skill Development
08	25IL5OE08	Any other course with the approval of Principal

UG Third Year EXTC Program

Assessment Methodology

Type of Courses	Assessment Tools	Marks Distribution
Theory	**CA-20**	Certification: NPTEL (20 Marks) (Approved by Instructor) **OR** Any two Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Tutorial • MOOCs Certification (Approved by Instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Theory (VEC)	**CA-50**	• Active Participation = 5 marks • MCQ /Class Test= 10 marks • Assessment of the activity carried out by student = 25 marks • Assignment = 10 marks
Workshop	**CA-50**	• Active Participation = 5 marks • Trade 1# = 15 marks • Trade 2# = 15 marks • Trade 3# = 15 marks # Based on the performance and satisfactory completion of trade wise tasks.
Liberal Learning Courses (LLC)	**CA-50**	• Active Participation = 5 marks • Assessment of the Activity carried out by student = 25 marks • Cultural Event Participation = 10 marks • Technical Event Participation = 10 marks
Theory	**MSE**	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes) • Total Marks: 30
Theory	**ESE**	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks

		• For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (2 hours) • Total Marks: 50
Course - Laboratory	**TW- 25**	• Active Participation (Lab) = 5 marks • Laboratory Report = 10 marks • Laboratory Performance = 10 marks Based on the performance and satisfactory completion of assigned laboratory work.
Community Engagement Project (CEP)	**TW-25**	• Active Participation = 05 marks • Project Report = 10 marks • Progress Presentations (min 02) & Demonstration = 10 marks
Tutorial	**TW-25**	• Active Participation = 5 marks • Tutorial Submission = 20 marks Tutorials should cover the entire syllabus.
Laboratory	**OR-25**	Oral examination will be based on the entire syllabus.
Laboratory	**PR-25**	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Weightage of COs across all Assessments:

Course Outcomes	Weightage (Percentage)
CO-1, CO-2	20-30
CO-3, CO-4	40-50
CO-5, CO-6	20-30

Note: Total weightage of all COs should be 100%.

1. Course Vertical 1- Program Core Course (PCC): Total Credits: 14

<table>
<tr><th>Course Code</th><th>Course Name</th><th colspan="3">Teaching Scheme (Hrs. / Week)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td rowspan="6">25ET5PCC01</td><td rowspan="6">Data Communication and Networking</td><td>L</td><td>T</td><td>P</td><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>2</td><td>3</td><td>-</td><td>1</td><td>4</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td rowspan="2">Theory</td><td colspan="2">CA1</td><td>CA2</td><td>MSE</td><td>ESE</td><td>Total</td></tr>
<tr><td colspan="2">10</td><td>10</td><td>30</td><td>50</td><td>100</td></tr>
<tr><td rowspan="2">Lab</td><td colspan="2"></td><td>TW</td><td>OR</td><td>PR</td><td></td></tr>
<tr><td colspan="2">-</td><td>25</td><td></td><td>25</td><td>50</td></tr>
</table>

Pre-Requisite Course:	Analog and Digital Communication

Course Overview

This course provides a comprehensive understanding of data communication and computer networking concepts that form the foundation of modern digital communication systems. Students will learn how data is transmitted, routed and managed across computer networks using standard communication protocols and networking architectures. The course develops analytical and problem-solving skills related to network design, addressing, routing and reliable data communication. It also introduces emerging technologies such as mobile communication and secure networking, enabling students to understand the role of communication networks in real-world applications

Module Overview

Module 1: Data Communication Fundamentals and Network Architecture

This module introduces the fundamental concepts of data communication and computer networks. It enables students to understand network communication using layered architectures, communication protocols, addressing concepts, and networking devices.

Module 2: Physical Layer and Transmission Techniques

This module introduces the principles of data transmission through guided and wireless communication media. It covers transmission media, channel characteristics, transmission impairments, and switching techniques used for efficient data communication.

Module 3: Data Link Layer and LAN Fundamentals

This module introduces the functions of the Data Link Layer for reliable node-to-node communication. It covers framing, flow control, error control, medium access techniques, HDLC, and Ethernet, providing the foundation for understanding local area networks and shared communication systems.

Module 4: Network Layer and Internet Protocols

This module explains Internet addressing, packet delivery, and routing in computer networks. It covers IP addressing, routing principles, routing algorithms, congestion control, and Quality of Service (QoS) concepts

Module 5: Transport and Application Layer Services

This module introduces end-to-end communication services and commonly used Internet application protocols. It explains connection-oriented and connectionless transport services, client-server communication, and the operation of widely used application layer protocols.

Module 6: Fundamentals of Mobile Communication and Network Security

This module introduces the fundamentals of mobile communication, along with the need for secure communication and basic network security principles.

Course Outcomes	After successful completion of the course, the students will be able to	
	CO1	Define the fundamental concepts, terminology, network architecture, protocols communication media, networking devices and network security principles. (Remember)
	CO2	Explain the functions and operations of the OSI and TCP/IP models, switching techniques, transmission media, routing mechanisms, mobile communication systems and network security concepts and laboratory tools used in computer networks. (Understand)
	CO3	Apply networking concepts, IP addressing, subnetting, supernetting, error detection techniques, routing principles, transport protocols network configuration techniques, and laboratory tools to solve communication and networking problems. (Apply)
	CO4	Analyze the performance and operation of communication networks, transmission techniques, routing algorithms, protocol interactions, error control mechanisms, and network traffic using appropriate analytical and simulation tools.
	CO5	Evaluate the network performance and suitability of communication technologies, mobile communications and network security approaches and practical implementations based on technical and application requirements for modern networking applications. (Evaluate).
	CO6	Design and implement reliable computer network solutions by integrating appropriate communication technologies, addressing schemes, routing techniques, transport services, application protocols, and network analysis tools to meet specified requirements. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Fundamentals of Data Communication and Network Architecture**	07
		After completing this module, students will be able to: • Explain the principles and applications of data communication and computer networks. • Describe the OSI and TCP/IP reference models. • Identify networking devices, addressing concepts and communication protocols.	
	1.1	**Data Communication Fundamentals** Introduction to Computer Networks and its applications, Types of Networks- LAN, MAN, WAN, Network Topologies, Data Communication Components, Addressing Concepts -physical/logical/port.	
	1.2	**Network Architecture and Devices** Need for layered protocol architecture, OSI reference model and functions of layers, TCP/IP protocol suite, comparison of OSI and TCP/IP models, network devices: repeater, hub, bridge, switch, router, gateway and firewall.	
		Self-Learning Topics: Real-world applications of networking in smart systems and industries.	
2		**Physical Layer and Data Transmission Techniques**	06
		After completing this module, students will be able to: • Compare different guided and wireless transmission media used in communication networks. • Explain the characteristics of transmission media and the factors affecting data transmission. • Differentiate between circuit switching and packet switching techniques.	
	2.1	**Transmission Media and Characteristics** Guided transmission media: Twisted pair cable, Coaxial cable and Optical fiber cable, Wireless Transmission Media, Transmission Impairments: Attenuation, Distortion and Noise.	
	2.2	**Switching Techniques** Channel characteristics, bandwidth and data rate concepts; Circuit switching, Packet switching, Signal Transmission in communication networks.	
		Self-Learning Topics: Latest Wireless Communication Technologies (Wi-Fi 6, Li-Fi)	
3		**Data Link Layer and LAN Technologies**	08
		After completing this module, students will be able to: • Explain the services provided by the Data Link Layer for reliable	

	communication between network nodes. • Explain the functions of the Data Link Layer and mechanisms for reliable data communication. • Analyze the operation of channelization and random-access techniques used for medium sharing in communication networks. • Explain HDLC and Ethernet frame structures and their role in LAN communication.		
	3.1	**Reliable Data Communication** Data link layer services, framing techniques, flow control and error control, parity check, Checksum, CRC, ARQ protocols, concept of piggybacking.	
	3.2	**HDLC and LAN Communication Fundamentals** Channelization Techniques: FDMA, TDMA, CDMA; Random Access Techniques: ALOHA, Slotted ALOHA, CSMA, CSMA/CD; HDLC frame format; IEEE 802.3 Ethernet frame structure and Ethernet operation.	
	Self-Learning Topics: Wireless LAN technologies and IEEE 802.11 overview		
4	**Network Layer and Internet Protocols**		**10**
	After completion of this module, students will be able to: • Apply IPv4 addressing, subnetting and supernetting techniques in communication networks. • Explain the functions of ARP and ICMP protocols. • Analyze routing methods and routing algorithms used in packet delivery.		
	4.1	**IP Addressing and Internet Protocols** IPv4 datagram format; IPv4 addressing, classful and classless addressing (CIDR); subnetting and supernetting; IPv4 and IPv6 addressing concepts and comparison; address resolution and error reporting using ARP and ICMP.	
	4.2	**Routing Principles and QoS** Routing concepts and strategies; Static and Dynamic routing; Distance vector and link state routing; Shortest path algorithms – Bellman-Ford Algorithm and Dijkstra's Algorithms, Congestion Control concepts and Quality of Service (QoS) parameters.	
	Self-Learning Topics: IPv6 deployment and future Internet addressing.		
5	**Transport Layer and Application Layer Services**		**08**
	After completing this module, students will be able to- • Differentiate between connection-oriented and connectionless transport services. • Explain the operation of TCP and UDP protocols and interpret their header formats. • Describe the working of common application layer protocols used in computer networks.		

	5.1	**Transport Layer Services** Functions and services of the transport layer; connection-oriented and connectionless communication; TCP services, TCP segment format, TCP connection establishment and termination; UDP services and UDP datagram format.	
	5.2	**Application Layer Services** Client-server communication model; domain name resolution, dynamic host configuration, file transfer, electronic mail and web services using DNS, DHCP, FTP, SMTP and HTTP protocols.	
	Self-Learning Topics: Working of HTTPS and secure web communication, Role of application protocols in modern Internet applications.		
6	**Fundamentals of Mobile Communication and Network Security**		**06**
	After completing this module, students will be able to: • Explain the evolution and key features of modern mobile communication systems. • Explain the need for secure communication and fundamental network security principles.		
	6.1	**Fundamentals of Mobile Communication** Cellular communication fundamentals, Evolution of Mobile Communication Systems, key features and applications of modern mobile networks.	
	6.2	**Fundamentals of Network Security** Need for secure communication in modern networks, Basic security principles, and Common network security threats and secure communication practices.	
	Self-Learning Topics: Emerging trends in 5G/6G communication, Cyber security awareness and safe networking practices.		
TOTAL			**45**

Suggested List of Experiments/Task:

Experiment/ Task No.	Title of Experiment/Task
1	**Title:** Study of Networking Devices and Transmission Media **Task:** Observe, identify and compare the operation of networking devices and transmission media used in computer networks. **Learning Objective:** To familiarize students with the role of networking devices and communication media in establishing and supporting network communication. **Learning Outcome:** Students will be able to identify networking devices and transmission media and explain their roles in communication networks.

2	**Title:** Network Configuration and Troubleshooting **Task:** Use network configuration and diagnostic commands to verify connectivity and troubleshoot network issues. **Learning Objective:** To familiarize students with commonly used network commands and their role in network configuration and fault diagnosis. **Learning Outcome:** Students will be able to configure basic network settings and use diagnostic commands to troubleshoot connectivity issues.

3	**Title:** Ethernet Cabling and Connectivity Verification **Task:** Fabricate straight-through and crossover Ethernet cables and verify their continuity and connectivity using a cable tester. **Learning Objective:** To understand Ethernet cabling standards, cable termination techniques, and connectivity testing procedures used in local area networks. **Learning Outcome:** Students will be able to prepare Ethernet cables following standard wiring schemes and verify cable integrity using cable testing tools.
4	**Title:** LAN Setup and Connectivity Verification **Task:** Connect multiple computers through a switch, assign IP addresses and verify communication. **Learning Objective:** To understand practical LAN implementation and device interconnection. **Learning Outcome:** Students will be able to configure a basic LAN, assign valid IP addresses and establish communication between networked devices.
5	**Title:** Network Topology Design **Task:** Design and implement different network topologies using Cisco Packet Tracer. **Learning Objective:** To study the structure and characteristics of various network topologies and their impact on network communication. **Learning Outcome:** Students will be able to design and analyze different network topologies for communication networks.
6	**Title:** IP Address Planning and Subnetting **Task:** Design and implement subnetting for a given network requirement. **Learning Objective:** To apply subnetting techniques for efficient IP address allocation and network design. **Learning Outcome:** Students will be able to perform subnet calculations and design subnet-based networks. Design and implement subnetting for a given network.
7	**Title:** Transport Layer Header Analysis **Task:** Capture and analyze TCP and UDP headers using Wire shark and identify the functions of various header fields. **Learning Objective:** To understand the structure and operation of transport layer protocols used for end-to-end communication. **Learning Outcome:** Students will be able to differentiate TCP and UDP operation through header analysis.

8	**Title:** Reliable Data Communication Analysis **Task:** Analyze the operation of ARQ protocols for reliable data communication. **Learning Objective:** To study acknowledgement, retransmission and error recovery mechanisms used in reliable communication. **Learning Outcome:** Students will be able to explain how ARQ protocols ensure reliable data transmission.
9	**Title:** ARP and ICMP Protocol Investigation **Task:** Observe ARP request/reply and ICMP messages using Wire shark and analyze their role in network communication. **Learning Objective:** To understand address resolution and network diagnostic mechanisms used in IP networks. **Learning Outcome:** Students will be able to analyze ARP and ICMP operations and explain their significance in IP communication.
10	**Title:** Error Detection Mechanism Implementation **Task:** Implement and analyze Checksum and CRC techniques for error detection. **Learning Objective:** To understand and compare error detection methods used in data communication systems. **Learning Outcome:** Students will be able to implement and evaluate Checksum and CRC techniques for detecting transmission errors.
11	**Title:** Shortest Path Routing Analysis **Task:** Implement a shortest-path routing algorithm and analyze route computation for a given network topology. **Learning Objective:** To understand the principles of routing and shortest-path determination in communication networks. **Learning Outcome:** Students will be able to determine shortest routes and analyze routing decisions in a network.
12	**Title:** TCP Connection Management Analysis **Task:** Capture and analyze TCP three-way handshake, connection establishment and termination processes using Wire shark. **Learning Objective:** To study connection-oriented communication and TCP session management. **Learning Outcome:** Students will be able to explain TCP connection establishment and termination procedures.
13	**Title:** Dynamic IP Address Allocation **Task:** Configure DHCP and verify the DORA process. **Learning Objective:** To understand dynamic IP address allocation and the operation of the DHCP protocol. **Learning Outcome:** Students will be able to configure DHCP services and explain the DORA process.

14	**Title:** File Transfer and Email Communication Analysis **Task:** Capture and analyze FTP and SMTP packets using Wire shark and examine file transfer and email communication processes. **Learning Objective:** To understand the operation of application layer protocols used for file transfer and electronic mail services. **Learning Outcome:** Students will be able to analyze FTP and SMTP communication and explain their roles in network applications.
15	**Title:** Web Communication Analysis **Task:** Capture and analyze HTTP request and response messages using Wire shark. **Learning Objective:** To study client-server communication and web application data exchange. **Learning Outcome:** Students will be able to explain HTTP-based web communication through packet analysis.

Textbooks:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Communication Networks -Alberto Leon Garcia, McGraw Hill Education, Second edition
3. Data and Computer Communications"- WilliamStallingsPearsonEducation, 10th Edition.
4. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013.

Reference Books:

1. Computer Networking: A Top-Down Approach, by J.F.Kurose and K.W.Ross, Addison-Wesley, 5th Edition.
2. Bhushan Trivedi, "Data Communication and Network", Oxford Publication Press, 1st edition.

Useful Links:

1. Communication Networks by By Prof. Goutam Das, IIT Kharagpur
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee61
3. Computer Networks and Internet Protocol, IIT Kharagpur by Prof. Soumya Kanti Ghosh Prof. Sandip Chakraborty, https://nptel.ac.in/courses/106105183
4. Demystifying Networking, By Prof. Sridhar Iyer, Prof. Ashutosh Raina, IIT Bombay,
5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs125
6. Advanced Computer Networks by Prof. Neminath Hubballi, Prof. Sameer G Kulkarni, IIT Indore, IIT Gandhi nagar, https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs02

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.
Practical & Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET5PCC02	Communication Data Analytics	L	T	P	L	T	P	Total
		3	-	2	3	-	1	4
		Examination Scheme						
		Theory	CA 1	CA 2	MSE	ESE	Total	
			10	10	30	50	100	
		Lab		TW	OR	PR		
			-	25	-	25	50	

Pre-requisite Courses	25FE1BSC01 Fundamentals of Engineering Mathematics -I
	25FE2BSC01 Fundamentals of Engineering Mathematics-II
	25ET3PCC01 Mathematics for Signal Processing

Course and Module Overview:

This course introduces data analytics techniques used for analyzing communication, signal, sensing and engineering datasets. Building upon the foundations established in Engineering Mathematics and Mathematics for Signal Processing, the course emphasizes statistical modelling, stochastic analysis, information measures, optimization techniques, linear algebra and computational intelligence. The course focuses on extracting meaningful insights from communication-related data and developing data-driven problem-solving skills using open-source computational tools. Students will learn to analyse, model and interpret data generated from communication, sensing and intelligent systems.

Module Overview

Module 1: Statistical Foundations for Communication Data Analytics

This module introduces statistical techniques used for analyzing communication and engineering datasets. Topics include probability distributions, correlation analysis, estimation methods, hypothesis testing, sample size determination, ANOVA, and Bayesian concepts. Students will learn to apply statistical methods to extract insights, validate assumptions, and support data-driven decision-making in communication and intelligent systems.

Module 2: Stochastic Signal and Data Modelling

This module focuses on modelling uncertainty and randomness in communication and sensing data using stochastic processes. Students will study random processes, stationarity, ergodicity, correlation functions, spectral analysis, and noise modelling techniques. The module provides the foundation for analyzing time-varying signals and understanding the behaviour of data generated from communication and sensing systems.

Module 3: Information Analytics and Data Representation

This module introduces information-theoretic concepts used for analyzing and representing communication data. Topics include entropy, mutual information, channel capacity, and data redundancy. Students will learn to quantify information content, evaluate data efficiency, and analyse information transfer in communication and intelligent systems.

Module 4: Optimization Techniques for Data Analytics

This module introduces optimization methods used in data analytics and engineering problem solving. Students will learn problem formulation, optimization techniques, parameter estimation, and gradient-based approaches for improving system performance. The module develops analytical and quantitative decision-making skills required for data-driven engineering applications.

Module 5: Linear Algebra for Communication Data Analytics

This module introduces linear algebraic techniques used for analysing multidimensional communication and engineering datasets. Topics include vector spaces, orthogonality, eigenvalue analysis, Singular Value Decomposition (SVD), and Principal Component Analysis (PCA). Students will learn to perform dimensionality reduction, feature extraction, and data interpretation for modern analytics applications.

Module 6: Intelligent Analytics for Communication Systems

This module introduces intelligent data analytics techniques used in communication and connected systems. Topics include similarity measures, feature spaces, classification concepts, clustering methods, and decision boundaries. Students will learn to analyse data patterns, develop intelligent decision-making models, and apply analytics techniques to communication and engineering applications.

Course Outcomes	After successful completion of the course, the students will be able to:	
	CO1	Recall the fundamental concepts of probability, stochastic processes, information theory, optimization, linear algebra and intelligent analytics used in communication data analysis. (Remember)
	CO2	Explain the significance of statistical, stochastic, information-theoretic and optimization concepts used in communication data analytics and intelligent systems. (Understand)
	CO3	Apply statistical models, estimation techniques, optimization methods and linear algebraic tools to analyze communication and engineering datasets. (Apply)
	CO4	Analyze stochastic processes, information measures and multidimensional datasets using appropriate analytical techniques. (Analyze)
	CO5	Evaluate suitable analytical approaches for communication, sensing and intelligent systems based on data characteristics and problem requirements. (Evaluate)
	CO6	Develop data analytics models and simulations for communication, sensing and intelligent systems using open-source software tools. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Statistical Foundations for Communication Data Analytics**	10
		After completing this module, students will be able to apply statistical modelling, estimation and hypothesis testing techniques for analyzing communication and engineering datasets.	
	1.1	Joint, conditional and marginal probability distributions, covariance, correlation, multivariate Gaussian distribution and sample size determination.	
	1.2	Estimation concepts, Maximum Likelihood Estimation (MLE), Introduction to Hypothesis Testing, Z-test, T-test and Chi-square test.	
	1.3	One-way ANOVA (Analysis of Variance), introduction to Bayesian estimation and engineering applications.	
		Self-Learning Topics: Statistical analysis and hypothesis testing for engineering datasets.	
2		**Stochastic Signal and Data Modelling**	07
		After completing this module, students will be able to analyze stochastic signals, random processes and noise characteristics encountered in communication and sensing applications.	
	2.1	Random processes, classification of random processes, stationarity and ergodicity.	
	2.2	Autocorrelation and cross-correlation functions for time-series and communication data.	
	2.3	Power Spectral Density (PSD), white noise, coloured noise and Gaussian random processes.	
		Self-Learning Topics: Noise modelling and stochastic analysis of communication datasets.	
3		**Information Analytics and Data Representation**	06
		After completing this module, students will be able to evaluate information measures and analyze data representation techniques used in communication and intelligent systems.	
	3.1	Information content and entropy and information measures.	
	3.2	Joint entropy, conditional entropy and mutual information.	
	3.3	Channel capacity, Shannon's theorem, coding efficiency and redundancy.	
		Self-Learning Topics: Entropy analysis of text, image and communication data.	

4	**Optimization Techniques for Data Analytics**		
	After completing this module, students will be able to formulate and solve data-driven optimization problems using appropriate computational techniques.		
	4.1	Optimization problem formulation and engineering applications.	**06**
	4.2	Convex and non-convex functions, unconstrained optimization techniques.	
	4.3	Gradient-based methods, least squares estimation and introductory linear programming concepts.	
	Self-Learning Topics: Optimization applications in communication system design.		
5	**Linear Algebra for Communication Data Analytics**		
	After completing this module, students will be able to analyze multidimensional communication and engineering datasets using advanced linear algebraic techniques.		
	5.1	Vector spaces, subspaces, orthogonality and projections.	**08**
	5.2	Eigenvalues and eigenvectors with communication and engineering applications.	
	5.3	Singular Value Decomposition (SVD), Principal Component Analysis (PCA) and dimensionality reduction.	
	Self-Learning Topics: PCA-based feature extraction for image and signal datasets.		
6	**Intelligent Analytics for Communication Systems**		
	After completing this module, students will be able to apply intelligent analytics techniques for classification, clustering and data-driven decision making in communication and connected systems.		
	6.1	Distance measures, similarity metrics and feature spaces.	**07**
	6.2	Classification concepts, decision boundaries and performance evaluation metrics.	
	6.3	Clustering fundamentals and performance measures, introduction to Edge Analytics for communication systems – data acquisition, feature extraction, FFT based analysis, data reduction, decision making at the edge.	
	Self-Learning Topics: Mathematical modelling of classification and clustering problems, recent trends in edge analytics applications.		
	TOTAL		**45**

Suggested List of Experiments/Tasks:

Experiment/ Task No.	Title of Experiment/Task
1	**Statistical Analysis and Visualization of Communication Datasets using Python** **Task**: Statistical Analysis and Visualization of Communication Datasets using Python. **Learning Objective**: To develop practical understanding of statistical measures and data visualization techniques for analysing communication and engineering datasets. **Learning Outcome**: Upon successful completion of this experiment, students will be

	able to compute statistical parameters, visualize datasets and interpret data patterns for communication and engineering applications.
2	**Joint Probability Distribution and Correlation Analysis** **Task**: Joint Probability Distribution and Correlation Analysis. **Learning Objective**: To study the dependence between random variables and understand statistical relationships in communication datasets. **Learning Outcome**: Upon successful completion of this experiment, students will be able to evaluate joint and conditional probabilities, determine covariance and correlation coefficients, and analyse relationships among random variables.
3	**Statistical Hypothesis Testing using Python** **Task**: Statistical Hypothesis Testing using Python (Z-test, T-test and Chi-square Test). **Learning Objective**: To develop practical skills in performing statistical significance tests on communication and engineering datasets. **Learning Outcome**: Upon successful completion of this experiment, students will be able to perform Z-test, T-test and Chi-square test and interpret the statistical significance of analytical results.
4	**Maximum Likelihood Estimation and Bayesian Analysis** **Task**: Maximum Likelihood Estimation and Bayesian Analysis. **Learning Objective**: To provide hands-on experience in parameter estimation and probabilistic decision-making techniques. **Learning Outcome**: Upon successful completion of this experiment, students will be able to estimate unknown parameters, compute posterior probabilities and interpret estimation accuracy.
5	**Simulation of Random Processes and Stationarity Analysis** **Task**: Simulation of Random Processes and Stationarity Analysis. **Learning Objective**: To understand the behaviour of random processes and analyse their statistical properties. **Learning Outcome**: Upon successful completion of this experiment, students will be able to generate random processes, analyse stationarity characteristics and interpret stochastic behaviour in engineering systems.
6	**Autocorrelation and Cross-Correlation Analysis of Time-Series Data** **Task**: Autocorrelation and Cross-Correlation Analysis of Time-Series Data **Learning Objective**: To investigate similarity measures and correlation characteristics of communication and time-series datasets. **Learning Outcome**: Upon successful completion of this experiment, students will be able to compute autocorrelation and cross-correlation functions and use them for pattern identification and signal characterization.
7	**Power Spectral Density Analysis of Random Signals** **Task**: Power Spectral Density Analysis of Random Signals. **Learning Objective**: To study the frequency-domain representation of stochastic signals and noise processes. **Learning Outcome**: Upon successful completion of this experiment, students will be able to estimate power spectral density, analyse signal power distribution across frequencies and interpret spectral characteristics of random signals.
8	**Information Analytics using Entropy, Mutual Information and Channel Capacity** **Task**: Information Analytics using Entropy, Mutual Information and Channel Capacity

	Learning Objective: To investigate information measures used for analysing communication datasets and information transfer. **Learning Outcome**: Upon successful completion of this experiment, students will be able to compute entropy, mutual information and channel capacity and evaluate the efficiency of information representation.
9	**Least Squares Estimation and Gradient-Based Optimization** **Task**: Least Squares Estimation and Gradient-Based Optimization. **Learning Objective**: To develop practical skills in optimization and mathematical modelling of engineering datasets. **Learning Outcome**: Upon successful completion of this experiment, students will be able to formulate optimization problems, perform least squares estimation and implement gradient-based optimization techniques.
10	**Eigenvalue and Eigenvector Analysis** **Task**: Eigenvalue and Eigenvector Analysis. **Learning Objective**: To demonstrate the application of linear algebra techniques in communication data analytics. **Learning Outcome**: Upon successful completion of this experiment, students will be able to compute eigenvalues and Eigen vectors, interpret their significance and apply them to multidimensional datasets.
11	**Principal Component Analysis (PCA)** **Task**: Principal Component Analysis (PCA). **Learning Objective**: To study feature extraction and dimensionality reduction techniques used in communication data analytics. **Learning Outcome**: Upon successful completion of this experiment, students will be able to perform Principal Component Analysis, reduce data dimensionality and analyse dominant features in multidimensional datasets.
12	**Classification and Clustering of Communication Datasets** **Task**: Classification and Clustering of Communication Datasets. **Learning Objective**: To introduce intelligent analytics techniques used for pattern recognition and data grouping. **Learning Outcome**: Upon successful completion of this experiment, students will be able to apply classification and clustering techniques, evaluate grouping patterns and interpret intelligent decision-making outcomes.
13	**Decision Boundary Visualization and Similarity Analysis** **Task**: Decision Boundary Visualization and Similarity Analysis. **Learning Objective:** To understand decision-making concepts and similarity measures used in communication data analytics. **Learning Outcome:** Upon successful completion of this experiment, students will be able to visualize decision boundaries, compute similarity measures and analyse classification performance.

Reference Books:

1. P. R. Vittal, Probability and Random Processes, Margham Publications.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. Rajaraman V. Computer-Oriented Numerical Methods, PHI
5. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India.

Useful Links:

1. https://nptel.ac.in/courses/106106139
2. https://nptel.ac.in/courses/111101165

Virtual Lab Links:

1. https://www.vlab.co.in/
2. https://vlabs.iitkgp.ac.in/
3. https://vlab.co.in/broad-area-electronics-and-communications

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.
Practical & Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Course Vertical 2- Program Elective Course (PEC): Total Credits: 03

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET5PEC01	Cryptography and Network Security	L	P	T	L	P	T	Total
		2	-	2	2	-	1	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	25	-	50

Pre-Requisite Courses:	25FE1VSEC02 Problem Solving using C programming
	25FE2BSC01 Fundamentals of Engineering Mathematics II
	25FE2VSEC02 Object Oriented Programming using Python
	25ET3PCC04 Analog and Digital Communication

Course and Module Overview:

This course introduces the principles of cryptography and network security required for modern telecommunication systems. It develops understanding of security threats, encryption techniques, authentication mechanisms, and secure communication protocols used in wired and wireless networks. The course emphasizes practical security applications in communication systems, IoT networks, cloud-connected devices, and next-generation wireless technologies.

Spanning over six modules with integrated self-learning topics, the course focuses on application-oriented cryptographic techniques and communication security mechanisms rather than advanced mathematical derivations. Students gain exposure to security architectures used in wireless communication, cellular networks, secure Internet communications, and emerging communication technologies.

Module Overview

Module 1- Introduction to Cryptography

This module introduces communication security fundamentals including security goals, threats, attacks, services, mechanisms, and classical cryptographic technique

Module 2- Symmetric Key Cryptography

This module covers mathematical foundations of cryptography, modular arithmetic, prime numbers, and symmetric key cryptographic algorithms such as DES and AES.

Module 3- Public Key Cryptography and Key Management

This Module focuses on public key cryptography, RSA, Diffie-Hellman key exchange, elliptic curve cryptography fundamentals, and public key infrastructure.

Module 4- Data Integrity and Authentication

This Module deals with data integrity, cryptographic hash functions, message authentication codes, digital signatures, and authentication protocols used in secure communications.

Module 5- Secure Communication Protocols

This module examines secure communication protocols including TLS, HTTPS, IPsec, VPNs, firewalls, and intrusion detection systems used in communication networks.

Module 6 - Wireless and Emerging Communication Security

This module explores wireless communication security, IoT security, cloud security, block chain fundamentals, post-quantum cryptography, and security challenges in 4G/5G communication systems.

Course Outcomes (COs)	**After successful completion of the course, the students will be able to:**	
	CO1	To define and state fundamental concepts of communication security, security goals, security attacks, cryptographic terminology, and security mechanisms used in communication systems. (Remember)
	CO2	To explain the principles of classical cryptography, symmetric key cryptography, public key cryptography, authentication mechanisms, and secure communication protocols. (Understand)
	CO3	To apply cryptographic algorithms and key management techniques to secure communication systems and networks. (Apply)
	CO4	To analyze data integrity mechanisms, authentication protocols, digital signatures, and communication security architectures. (Analyze)
	CO5	To evaluate the effectiveness of security protocols and wireless communication security mechanisms for different communication applications. (Evaluate)
	CO6	To design secure communication solutions using cryptographic techniques for wireless, IoT, and next-generation communication networks. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Cryptography**	05
		After completing this module, students will be able to: • Define cryptography, need of cryptography, and requirements of security goals, attacks, services, and mechanisms used in communication systems. • Explain the operation and limitations of various cryptographic techniques.	
	1.1	Communication Security Concepts: Confidentiality, Integrity, Availability (CIA), Authentication, Non-repudiation, Security Services and Mechanisms, Passive and Active Attacks, Threats in Communication Networks.	
	1.2	Introduction to Cryptography: Need of Cryptography, Encryption and Decryption Process, Symmetric and Asymmetric Cryptography, Classical Cryptographic Techniques: Types of Ciphers, Monoalphabetic Cipher, Caesar Cipher, Playfair Cipher, Transposition Cipher, Stream Cipher, Block Cipher.	
		Self-Learning Topics: Study the role of cryptography in secure messaging applications and compare classical cryptographic methods with modern encryption techniques.	
2		**Symmetric Key Cryptography**	05
		After completing this module, students will be able to: • Explain the number-theoretic concepts used in cryptographic systems. • Apply symmetric key cryptographic techniques for secure communication.	
	2.1	Number Theory Concepts for Cryptography: Prime Numbers, Modular Arithmetic, Euclidean Algorithm, Euler's Totient Function, Euler's Theorem, Fermat's Little Theorem.	
	2.2	Symmetric Key Cryptography: DES Overview, Double DES, Triple DES, AES Architecture and Comparison.	
		Self-Learning Topics: Compare AES implementations used in mobile phones, banking systems, and cloud applications.	
3		**Public Key Cryptography and Key Management**	05
		After completing this module, students will be able to: • Explain public key cryptographic principles. • Apply key exchange mechanisms for secure communication. • Analyse the role of PKI and digital certificates in communication security.	
	3.1	Public Key Cryptography: Principles of Public Key Systems, Public and Private Keys, RSA Algorithm, Key Generation Process, Digital Signatures, Applications of Public Key Cryptography.	

	3.2	Key Management: Diffie-Hellman Key Exchange, Elliptic Curve Cryptography (ECC) Basics, Public Key Infrastructure (PKI), Digital Certificates.	
	Self-Learning Topics: Study the use of digital certificates in secure websites and online banking systems.		
4	**Data Integrity and Authentication**		**05**
	After completing this module, students will be able to: • Apply cryptographic hash functions and authentication mechanisms for secure communication. • Analyse integrity and authentication requirements in communication systems.		
	4.1	Cryptographic Hash Functions: Requirements and Properties of Hash Functions, MD5, SHA Family, SHA-256, SHA-512.	
	4.2	Authentication Techniques: Message Authentication Codes (MAC), Hash-based Message Authentication Code (HMAC), Digital Signatures, RSA Digital Signatures, User Authentication Protocols.	
	Self-Learning Topics: Analyze digital signature applications in e-governance, secure email, and software authentication.		
5	**Secure Communication Protocols**		**05**
	After completing this module, students will be able to: • Apply secure communication protocols in networked environments. • Analyze protocol architectures used for communication security. • Evaluate security mechanisms for different communication applications.		
	5.1	Transport Layer Security: SSL Overview, TLS 1.3 Architecture, TLS Handshake Process, HTTPS.	
	5.2	Network Security Protocols: IPsec Architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), Virtual Private Networks (VPNs).	
	5.3	Network Protection Mechanisms: Firewalls, Intrusion Detection Systems (IDS), Intrusion Prevention Systems (IPS).	
	Self-Learning Topics: Investigate security protocols used in enterprise networks and remote access applications.		
6	**Wireless and Emerging Communication Security**		**05**
	After completing this module, students will be able to: • Analyze security challenges in wireless and IoT systems. • Evaluate emerging communication security technologies. • Design secure communication solutions for modern wireless and IoT applications.		
	6.1	Wireless Security: Wi-Fi Security Evolution (WEP, WPA2, WPA3),	

		Wireless LAN Security Challenges.	
	6.2	Cellular and Emerging Technologies: Security in 4G/5G Networks, IoT Security Fundamentals, Cloud Security Basics, Block chain Overview, Post-Quantum Cryptography Overview.	
	Self-Learning Topics: Explore security challenges in smart cities, industrial IoT, and next-generation wireless communication networks.		
	Total		**30**

Suggested List of Experiments/Tasks:

Experiment/ Task No.	Title of the Experiment/ Task
1	**To perform encryption and decryption using classical cryptographic techniques.** **Learning Objective**: To familiarize students with basic cryptographic terminology and classical encryption methods. **Learning Outcome:** Students will be able to identify and demonstrate the operation of classical cryptographic techniques.
2	**To perform modular arithmetic and number theoretic operations used in cryptography.** **Learning Objective**: To develop understanding of mathematical concepts used in secure communication systems. **Learning Outcome:** Students will be able to explain and interpret mathematical operations used in cryptographic algorithms.
3	**To encrypt and decrypt communication data using AES algorithm.** **Learning Objective**: To apply symmetric encryption techniques for secure communication. **Learning Outcome:** Students will be able to apply AES encryption and decryption for protecting communication data.
4	**To analyze the operation of block cipher modes such as ECB, CBC, CFB and CTR.** **Learning Objective**: To study practical implementation of block cipher modes. **Learning Outcome:** Students will be able to apply appropriate cipher modes for communication security applications.
5	**To implement RSA-based secure communication.** **Learning Objective**: To apply public key cryptographic techniques. **Learning Outcome:** Students will be able to perform encryption and decryption using RSA.
6	**To establish secure communication using Diffie-Hellman Key Exchange and analyze generated session keys.** **Learning Objective**: To study secure key establishment mechanisms. **Learning Outcome:** Students will be able to analyze secure key exchange procedures

	used in communication networks.
7	**To generate and compare cryptographic hash values using MD5, SHA-256 and SHA-512.** **Learning Objective**: To investigate integrity verification mechanisms. **Learning Outcome:** Students will be able to analyze characteristics and effectiveness of different hash functions.
8	**To generate and verify digital signatures.** **Learning Objective**: To investigate authentication mechanisms in secure communication. **Learning Outcome:** Students will be able to analyze digital signature generation and verification procedures.
9	**To inspect and validate digital certificates used in secure communication systems.** **Learning Objective**: To evaluate certificate-based authentication mechanisms. **Learning Outcome:** Students will be able to evaluate the trustworthiness and validity of digital certificates.
10	**To capture and analyze TLS/HTTPS communication using Wire shark.** **Learning Objective**: To evaluate security features of secure communication protocols. **Learning Outcome:** Students will be able to evaluate TLS-based communication mechanisms used in modern networks.
11	**Task No. 1** **Comparative Analysis of Security Attacks in Communication Systems** **Learning Outcome:** Students will be able to analyze attack mechanisms and associated vulnerabilities.
12	**Task No. 2** **Comparative Study of WEP, WPA, WPA2 and WPA3 Security Standards** **Learning Outcome:** Students will be able to evaluate wireless security protocols for communication applications.
13	**Task No. 3** **Security Assessment of Secure Web Communication Systems** **Learning Outcome:** Students will be able to evaluate website security configurations and certificate mechanisms.
14	**Task No. 4** **Comparative Analysis of VPN Technologies** **Learning Outcome:** Students will be able to evaluate VPN architectures for secure communication requirements.
15	**Task No. 5 (Compulsory)** **Design of a Secure Communication System for a Real-World Application** Examples: • Banking Communication System • Telemedicine Communication Network

	• Industrial Communication Network • Smart Grid Communication Network • University Campus Communication Network **Learning Objective**: To integrate cryptographic and communication security concepts into a complete communication solution. **Learning Outcome:** Students will be able to design a secure communication architecture incorporating confidentiality, integrity, authentication, and secure key management.

Text Books:

1. Cryptography and Network Security: Principles and Practice – William Stallings, Pearson Education, 8th Edition.
2. Network Security Essentials: Applications and Standards – William Stallings, Pearson Education, 7th Edition.
3. Cryptography and Network Security – Atul Kahate, McGraw Hill Education, 4th Edition.
4. Network Security and Cryptography – Bernard Menezes, Cengage Learning India, 2nd Edition.

Reference Books:

1. Understanding Cryptography: A Textbook for Students and Practitioners – Christof Paar, Jan Pelzl, Springer, 2nd Edition.
2. Computer Networking: A Top-Down Approach – James F. Kurose, Keith W. Ross, Pearson Education, 8th Edition.
3. Applied Cryptography: Protocols, Algorithms and Source Code in C – Bruce Schneier, John Wiley & Sons, 2nd Edition.
4. Security in Computing – Charles P. Pfleeger, Shari Lawrence Pfleeger, Pearson Education, 5th Edition.
5. Guide to Computer Network Security – Joseph Migga Kizza, Springer International Publishing, 5th Edition.
6. Handbook of Applied Cryptography – Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, CRC Press.

Useful Links:

Useful Links for Theory:

1. NPTEL Course on Cryptography and Network Security – https://nptel.ac.in
2. NPTEL Course on Computer Networks and Internet Protocol – https://nptel.ac.in
3. National Institute of Standards and Technology (NIST) Computer Security Resource Center – https://csrc.nist.gov
4. Internet Engineering Task Force (IETF) RFC Repository – https://www.rfc-editor.org
5. Open Web Application Security Project (OWASP) – https://owasp.org

Useful Links for Laboratory:

1. Wireshark Documentation – https://www.wireshark.org/docs
1. OpenSSL Documentation – https://www.openssl.org/docs
2. Cisco Packet Tracer Resources – https://www.netacad.com
3. Cryptool Learning Platform – https://www.cryptool.org
4. NPTEL Laboratory and Tutorial Resources – https://nptel.ac.in
5. NPTEL-Theory and Practice of Modern Cryptography: https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs101

Virtual Lab Links:

1. Virtual Labs, IIT Kharagpur – https://cse29-iiith.vlabs.ac.in
2. OpenSSL Documentation – https://www.openssl.org/docs
3. Cisco Packet Tracer Resources – https://www.netacad.com

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.
Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET5PE02	Image Analytics and Machine Vision	L	P	T	L	P	T	Total
		2	-	2	2	1	-	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	25	-	50

Pre-Requisite Courses:	25ET4PCC01 Discrete Time Signal Processing

Course and Module Overview:

Image Processing and Machine Vision is an interdisciplinary course that integrates digital image analysis, computer vision, machine learning, and intelligent visual analytics. The course provides a strong foundation in image acquisition, enhancement, restoration, segmentation, feature extraction, and machine vision systems. Students will learn both classical image processing techniques and modern machine learning-based vision algorithms used in industrial automation, healthcare imaging, surveillance, autonomous systems, quality inspection, remote sensing, and intelligent manufacturing.

The course emphasizes practical implementation using Python/OpenCV and machine learning frameworks, enabling students to design and develop intelligent image analysis solutions. Through laboratory experiments and mini-projects, learners gain hands-on experience in solving real-world visual inspection and image analytics problems.

Module Overview

Module 1- Fundamentals of Digital Image

This module introduces digital image fundamentals, image representation models, pixel relationships, and connectivity, sampling, quantization, and intensity transformations. Students will learn histogram-based enhancement techniques for improving image quality and contrast.

Module 2 - Advanced Image Enhancement and Filtering

This module focuses on spatial and frequency-domain image enhancement techniques. Students will study smoothing and sharpening filters, edge enhancement operators, and frequency-domain filtering using Fourier transforms.

Module 3 - Morphological Processing and Image Restoration

This module introduces morphology-based image analysis and restoration techniques for degraded images. Students learn shape-based processing and noise removal approaches.

Module 4- Image Segmentation and Feature Extraction

This module explores image segmentation techniques used to isolate meaningful regions and objects. Students will learn edge-based, region-based, and threshold-based segmentation methods.

Module 5- Machine Vision and Features

This module covers object representation and feature extraction techniques used in machine vision systems. Students will explore shape analysis and texture-based feature extraction.

Module 6- Machine Learning for Image Analytics

This module introduces machine learning techniques for image analytics. Students learn data preparation,performance evaluation metrics, and image classification using supervised learning algorithms.

	After successful completion of the course, the students will be able to:	
Course Outcomes (COs)	CO1	Recall the concepts and techniques of digital image processing and machine vision. (Remember)
	CO2	Explain image enhancement, filtering, restoration, segmentation, and feature extraction methods. (Understand)
	CO3	Apply image processing and machine learning techniques to analyze digital images. (Apply)
	CO4	Analyze image characteristics, features, and classification results for visual interpretation. (Analyze)
	CO5	Evaluate the performance of image processing and classification methods using quantitative measures. (Evaluate)
	CO6	Design machine vision solutions by integrating image processing and machine learning techniques. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Fundamentals of Digital Image**	06
		After completing this module, students will be able to: • Recognize the fundamentals of digital image processing and image representation. • Discuss spatial and intensity resolution, pixel relationships, and connectivity. • Implement image transformation and histogram-based enhancement techniques for image quality improvement.	
	1.1	Digital Image Fundamentals: Steps in Digital Image Processing, Digital image representation, Spatial and intensity resolution, Pixel relationships and connectivity.	
	1.2	Image Transformations: Image Negative, Log Transform, Power Law transform, Contrast stretching, Bit-plane slicing, Histogram equalization and Histogram Specification.	
		Self-Learning Topics: HDR imaging.	
2		**Advanced Image Enhancement and Filtering**	08
		After completing this module, students will be able to: • Interpret the principles of spatial and frequency-domain image enhancement techniques. • Utilize spatial filtering techniques for image smoothing, sharpening, and noise removal. • Assess frequency-domain filtering techniques for image enhancement.	
	2.1	Spatial Domain Enhancement: The Mechanics of Spatial Filtering Smoothing Spatial Filters: Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal Sharpening Spatial Filters- The Laplacian sharpening, Unsharp Masking and High boost Filtering, Gradient operators.	
	2.2	Frequency Domain Processing: 2D Fourier Transform, Steps for Filtering in the Frequency Domain, Frequency domain Image Enhancement-Butterworth, Gaussian filters.	
		Self-Learning Topics: Wavelet transform, Haar transform, Discrete Cosine Transform (DCT).	
3		**Morphological Processing and Image Restoration**	06
		After completing this module, students will be able to: • Illustrate the concepts of morphological image processing and image restoration. • Demonstrate morphological operations and restoration techniques for image analysis.	

	• Distinguish the effectiveness of morphological processing and restoration techniques for image analysis.		
	3.1	Morphology: Structuring elements, Erosion and Dilation, Opening and Closing, Hit-or-Miss Transformation, Boundary extraction, Thinning and thickening.	
	3.2	Restoration: A Model of the Image Degradation/Restoration Process, Noise models.	
	Self-Learning Topics: Removal periodic noise, Principle of Inverse filtering.		
4	**Image Segmentation and Feature Extraction**		**06**
	After completing this module, students will be able to: • Apply edge-based, region-based, and threshold-based segmentation techniques for object extraction. • Analyze segmentation methods for accurate object and boundary detection. • Evaluate the effectiveness of image segmentation techniques for different image analysis applications		
	4.1	Edge-Based Segmentation: Detection of Isolated Points, Line detection, Canny's edge detection algorithm, Edge linking, Boundary detection.	
	4.2	Region Based segmentation: Region Growing, Region Splitting and Merging.	
	4.3	Thresholding: Foundation, Role of illumination and reflectance.	
	Self-Learning Topics: Types of thresholding.		
5	**Machine Vision and Features**		**04**
	After completing this module, students will be able to: • Describe the principles of machine vision and feature extraction techniques. • Implement shape and texture feature extraction techniques using chain codes, shape descriptors, and GLCM. • Inspect shape and texture features for image representation and machine vision applications.		
	5.1	Principle of machine vision, Chain codes, Simple geometric border representation, Shape descriptors.	
	5.2	Feature Extraction and Representation: Texture analysis, Gray Level Co-occurrence Matrix (GLCM).	
	Self-Learning Topics: Histogram of Oriented Gradients (HOG) Features.		
6	**Machine Learning for Image Analytics**		**04**
	After completing this module, students will be able to: • Examine machine learning techniques and classification models for image analytics. • Validate the performance of image classification models using standard		

	performance metrics. • Construct machine learning-based image analytics solutions using appropriate classification models and evaluation techniques.		
	6.1	Machine Learning for Image Analytics: Supervised learning, Unsupervised learning, Dataset preparation, Performance metrics- Precision, Recall, F1 Score.	
	6.2	Classification Models: Support Vector Machines, K-Nearest Neighbors.	
	Self-Learning Topics: K means Clustering.		
	Total		**30**

Suggested List of Experiments/ Task:

Experiment/ Task No.	Title of the Experiment/ Task
1	**Image Acquisition and Basic Image Operations** **Learning Objectives:** Perform basic image manipulation operations using Python/Open CV to understand digital image representation and image formats. **Task:** • Read and display grayscale and color images. • Perform image resizing, cropping, rotation, and flipping. • Analyze image histograms. **Learning Outcomes:** Interpret image properties and histogram information.
2	**Point Processing and Intensity Transformations** **Learning Objectives:** Apply point processing techniques for image enhancement to understand intensity transformation functions. **Task:** • Image negative transformation. • Log and power-law transformations. • Contrast stretching. **Learning Outcomes:** Implement point processing operations to enhance image quality.
3	**Histogram Processing Techniques** **Learning Objectives**: Analyse image intensity distributions to improve image quality using histogram-based enhancement. **Tasks:** • Histogram generation. • Histogram equalization. • Histogram specification. **Learning Outcomes:** Evaluate image contrast using histograms by applying histogram-based enhancement techniques effectively.
4	**Spatial Domain Filtering**

	Learning Objectives: Apply spatial filtering for enhancement to understand noise removal and image smoothing techniques**.** **Task**: • Mean filtering. • Gaussian filtering. • Median filtering**.** **Learning Outcomes:** Select suitable filters for noise removal and analyze the effect of smoothing filters on image quality.
5	**Image Sharpening Techniques** **Learning Objectives:** To **e**nhance image details using sharpening methods. **Task:** • Laplacian filtering. • Unsharp masking. • High-boost filtering. • Sobel, Prewitt, and Roberts operators. **Learning Outcomes:** Implement image sharpening algorithms and compare edge enhancement methods.
6	**Frequency Domain Image Processing** **Learning Objectives:** Apply frequency-domain filters to understand frequency-domain image representation. **Task**: • 2D FFT implementation. • Butterworth filtering. • Gaussian filtering. **Learning Outcomes:** Implement frequency-domain enhancement techniques and analyze frequency components of images.
7	**Morphological Image Processing** **Learning Objectives:** Apply morphological operations for object manipulation. **Task**: • Erosion and dilation. • Opening and closing. • Boundary extraction. • Hole filling. **Learning Outcomes:** Perform shape-based image processing and extract meaningful structures from binary images.
8	**Advanced Morphological Operations** **Learning Objectives:** Analyze complex morphological transformations. **Task:** • Hit-or-Miss transformation. • Thinning.

	• Thickening. **Learning Outcomes:** Implement advanced morphology techniques and extract structural information.
9	**Edge Detection and Boundary Extraction** **Learning Objectives:** Detect image boundaries and discontinuities. **Task**: • Point and line detection. • Sobel edge detection. • Prewitt edge detection. • Canny edge detection. **Learning Outcomes:** Identify edges using different operator to compare edge detection algorithms.
10	**Region-Based Image Segmentation** **Learning Objectives:** Segment images into meaningful regions. Task: • Region growing. • Region splitting and merging. **Learning Outcomes:** Implement region-based segmentation algorithms to analyze segmentation performance.
11	**Texture Analysis using GLCM** **Learning Objectives**: To extract texture features from images and understand statistical texture descriptors. **Tasks:** • Construct Gray-Level Co-occurrence Matrix (GLCM). • Compute Contrast, Energy, Correlation, and Homogeneity. **Learning Outcomes:** To extract texture features from images to interpret texture characteristics using GLCM features.
12	**Machine Learning-Based Image Classification** **Learning Objectives**: Apply machine learning techniques for image analytics and evaluate classification performance. **Tasks:** • Dataset preparation. • Feature extraction using GLCM. • Classification using KNN and SVM. • Compute Precision, Recall, F1-Score, and ROC-AUC. **Learning Outcomes:** Develop image classification models and evaluate classifier performance using standard metrics.

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 Interscience publication
4. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006A

Reference Books:

1. Anil K. Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, 1989.
2. W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002
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.

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.
Oral (25 Marks)	Practical examination will be based on the experiments performed by the students during laboratory sessions.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET5PEC03	RTL Design and Functional Verification	L	P	T	L	P	T	Total
		2	-	2	2	-	1	3
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	25	-	50

Pre-Requisite Courses:	25ET4PCC03: Digital VLSI Design
	25ET3PCC03: Digital System Design using Verilog
	25ET3VSEC01: Java Programming
	25FE1ESC02: Basic Electrical and Digital Electronics

Course and Module Overview:

This course provides an integrated treatment of Register-Transfer-Level (RTL) digital design and modern functional verification using Verilog and SystemVerilog. It bridges the gap between writing synthesizable hardware and proving that the hardware is correct — the two activities that dominate the front-end VLSI/SoC design cycle in industry. The course begins with the RTL design abstraction and the SystemVerilog language enhancements that make hardware modelling clearer and less error-prone, then advances through combinational, sequential and finite-state-machine modelling, hierarchical and reusable design, and finally to a complete coverage-driven, assertion-based functional verification methodology.

It is especially relevant for Electronics and Telecommunication (EXTC) students, because the digital blocks at the heart of modern communication systems — 5G/6G basebands, IoT controllers, protocol engines, and SoC interconnects — are first captured as RTL and then exhaustively verified before fabrication, where verification typically consumes more than half of the total project effort

Module Overview

Module 1- RTL Design Fundamentals and System Verilog for Design

This module establishes the RTL design abstraction, the simulation-to-synthesis flow, and the SystemVerilog data types and procedural constructs used for synthesizable design.

Module 2- RTL Modeling of Digital Systems

This module applies these constructs to model combinational logic, sequential logic, and finite state machines using clean, synthesis-safe coding styles.

Module 3- Hierarchical and Reusable RTL Design

This module develops hierarchical, parameterized and interface-based design so that RTL is reusable and scalable.

Module 4- Functional Verification Fundamentals and Testbench Architecture

This module introduces the functional-verification process and the object-oriented, layered testbench architecture that connects to a design under test.

Module 5- Constrained-Random Stimulus, IPC and Functional Coverage

This module builds constrained-random stimulus, inter-process communication, and functional coverage to drive verification toward coverage closure.

Module 6- Assertion-Based Verification and Methodology

This module completes the flow with SystemVerilog Assertions, assertion-based verification, and an introduction to standard verification methodology through a full self-checking environment.

Overall, the course equips EXTC students with industry-aligned RTL design competence and functional-verification skill, forming a strong foundation for advanced VLSI design, design-verification (DV) engineering roles, internships, and semiconductor careers.

	After successful completion of the course, the students will be able to:	
Course Outcomes (COs)	CO1	Recall the RTL design abstraction, System Verilog data types and constructs, design-flow stages, and basic functional-verification terminology. (Remember)
	CO2	Explain the simulation-to-synthesis design flow, synthesizable procedural constructs, object-oriented programming concepts, and coverage metrics used in verification. (Understand)
	CO3	Develop synthesizable RTL for combinational, sequential, and finite-state-machine based digital systems and build System Verilog test benches. (Apply)
	CO4	Analyze RTL behaviour, constrained-random stimulus, functional-coverage results, and design and verification trade-offs. (Analyze)
	CO5	Evaluate logic styles, coding choices, and verification completeness for performance, correctness, and coverage closure. (Evaluate)
	CO6	Design a complete, self-checking, assertion-based verification environment for a digital block following an RTL-to-verification flow. (Designee/ Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1.	**RTL Design Fundamentals and SystemVerilog for Design**		**05**
		After completing this module, students will be able to: • **Describe** the RTL abstraction and the simulation-to-synthesis design flow • **Explain** SystemVerilog 2-state/4-state data types, user-defined types, enums, structs and packages • **Apply** synthesizable procedural blocks (always_comb, always_ff, always_latch), operators and statements • **Differentiate** blocking and non-blocking assignments and avoid simulation race conditions	
	1.1	RTL design abstraction; digital design flow (specification → RTL → synthesis → gate-level → physical); behavioral, RTL and structural modelling; HDL vs HVL; SystemVerilog as a unified design-and-verification language.	01
	1.2	SystemVerilog data types for design: 2-state vs 4-state types (bit, logic), nets vs variables, literals, user-defined types (typedef), enumerated types, packed and unpacked arrays, structures, unions, packages.	02
	1.3	Synthesizable procedural blocks: always_comb, always_ff, always_latch; operators and procedural statements; enhancements to tasks and functions; synthesis guidelines.	02
	Self-Learning Topics: Blocking vs non-blocking assignments and simulation race conditions; SystemVerilog vs classic Verilog improvements.		
2.	**RTL Modeling of Digital Systems**		**05**
		After completing this module, students will be able to: • **Develop** combinational RTL while avoiding unintended latches and priority hazards • **Design** sequential RTL: registers, counters, shift registers and inferred memory • **Model** Moore and Mealy finite state machines with appropriate state encoding • **Apply** datapath-controller (FSMD) partitioning for digital systems	
	2.1	Combinational RTL: arithmetic and logic blocks, multiplexers, decoders, encoders, comparators; case/casez/casex; priority vs parallel logic; avoiding unintended latches and full/parallel-case issues.	02
	2.2	Sequential RTL: registers, counters, shift registers, register files; synchronous and asynchronous reset, clock enable; memory inference and coding.	01
	2.3	Finite State Machines: Moore vs Mealy modelling; binary, gray and one-hot encoding; one-process vs two-process vs three-process FSM styles; datapath-controller (FSMD) partitioning.	02
	Self-Learning Topics: Pipelining and retiming for high-speed RTL; clock-domain considerations.		
3.	**Hierarchical and Reusable RTL Design**		**05**
		After completing this module, students will be able to:	

		• **Construct** design hierarchy using modules, ports, and generate constructs • **Apply** parameters and type parameters to build configurable, reusable modules • **Use** SystemVerilog interfaces, modports and clocking blocks to structure connectivity • **Evaluate** RTL against verifiable coding-style and lint guidelines	
	3.1	Design hierarchy: modules and ports, named and positional connections, .name and .* shortcuts, nested modules, net aliasing; generate constructs for replicated and conditional hardware.	02
	3.2	Parameterization and reuse: parameters, localparam, type parameters, parameterized and configurable modules, design reuse and IP integration.	01
	3.3	SystemVerilog interfaces: interface, modports, clocking blocks; separating design and testbench; using interfaces in synthesizable design.	02
	Self-Learning Topics: Verifiable RTL coding-style guidelines, linting and design-rule checking.		
4.	**Functional Verification Fundamentals and Testbench Architecture**		**05**
		After completing this module, students will be able to: • **Explain** the verification process, verification plan, and coverage metrics • **Apply** object-oriented programming — classes, inheritance and polymorphism — for verification • **Build** a layered testbench (transaction, generator, driver, monitor, scoreboard) • **Connect** a testbench to a DUT using interfaces, clocking blocks and virtual interfaces	
	4.1	Verification process and verification plan; directed vs constrained-random verification; black-box, white-box and grey-box; simulation, formal and assertion-based verification; coverage metrics.	02
	4.2	Object-oriented programming for verification: classes, objects and handles, constructors, inheritance, polymorphism, virtual methods, shallow vs deep copy, randomization handles.	02
	4.3	Layered testbench architecture: transaction, generator, driver, monitor, scoreboard, environment; connecting the testbench to the DUT using interfaces, clocking blocks, virtual interfaces and program blocks.	01
	Self-Learning Topics: Testbench reuse and the motivation for the Universal Verification Methodology (UVM).		
5.	**Constrained-Random Stimulus, IPC and Functional Coverage**		**05**
		After completing this module, students will be able to: • **Apply** randomization and constraint blocks to generate legal, directed-random stimulus • **Use** threads, mailboxes, semaphores and events for inter-process communication • **Construct** functional coverage using covergroups, coverpoints and cross coverage • **Analyze** coverage results to drive a coverage-closed verification effort	
	5.1	Randomization: rand and randc, constraint blocks, constraint solving, inline and external constraints, weighted distributions, implication and iterative/array constraints, pre_randomize and post_randomize, random	02

		stability.	
	5.2	Threads and inter-process communication: fork/join, join_any, join_none; disabling threads; mailboxes, semaphores and events for synchronization.	01
	5.3	Functional coverage: covergroups, coverpoints, bins, cross coverage, coverage options and sampling; coverage-driven verification and coverage closure.	02
	Self-Learning Topics: Code coverage vs functional coverage; coverage convergence and regression.		
6.	**Assertion-Based Verification and Verification Methodology**		**05**
		After completing this module, students will be able to: • **Write** immediate and concurrent SystemVerilog Assertions (SVA) with sequences and properties • **Apply** assertion-based coverage and the bind construct to RTL • **Design** a self-checking environment with scoreboarding and regression • **Evaluate** verification completeness and relate it to standard methodology (UVM) building blocks	
	6.1	SystemVerilog Assertions (SVA): immediate vs concurrent assertions, Boolean expressions, sequences and properties, implication operators, sampled values, assertion-based coverage.	02
	6.2	Coverage, events and assertions in verifiable RTL; the bind construct; checkers; integrating assertions with design and testbench.	01
	6.3	Verification methodology overview: self-checking testbenches, scoreboarding, regression; introduction to UVM building blocks and reuse; complete environment case study.	02
	Self-Learning Topics: AI-assisted assertion generation and current trends in functional verification.		
		TOTAL	**30**

Suggested List of Experiments:

Experiment/ Task No.	Title of the Experiment/ Task
1	**SystemVerilog Data Types and a Combinational Block** **Learning Objective:** To explore SystemVerilog data types, user-defined types and operators by modelling and simulating a combinational block such as an ALU. **Learning Outcome:** Students will be able to use SystemVerilog data types and operators correctly and verify a combinational block by simulation.
2	**RTL Design of Combinational Circuits** **Learning Objective:** To design and simulate multiplexers, decoders, encoders and comparators in synthesizable RTL while avoiding unintended latches. **Learning Outcome:** Students will be able to write latch-free combinational RTL and analyze its functional correctness.
3	**RTL Design of Sequential Circuits** **Learning Objective:** To design and simulate counters, shift registers and a register file with appropriate reset and clock-enable schemes. **Learning Outcome:** Students will be able to model sequential RTL and verify reset, enable and timing behaviour.
4	**Finite State Machine Design** **Learning Objective:** To design a Moore and a Mealy FSM (e.g. sequence detector or traffic-light controller) and compare state-encoding styles. **Learning Outcome:** Students will be able to implement FSMs in clean coding styles and evaluate encoding trade-offs.
5	**Hierarchical and Parameterized Design** **Learning Objective:** To build a parameterized, hierarchical design using generate constructs and SystemVerilog interfaces. **Learning Outcome:** Students will be able to construct reusable, configurable RTL and connect blocks through interfaces.
6	**Directed Testbench Development** **Learning Objective:** To develop a directed testbench using tasks, functions, interfaces and clocking blocks to drive and sample a DUT. **Learning Outcome:** Students will be able to build a directed testbench and check DUT behaviour against expected results.
7	**Class-Based Layered Testbench** **Learning Objective:** To build a class-based layered testbench with transaction, generator, driver, monitor and scoreboard components. **Learning Outcome:** Students will be able to apply OOP to construct a reusable, layered verification environment.
8	**Constrained-Random Stimulus** **Learning Objective:** To generate constrained-random stimulus using rand/randc and constraint blocks and analyze constraint solving.

	Learning Outcome: Students will be able to create legal randomized stimulus and control distributions through constraints.
9	**Functional Coverage** **Learning Objective:** To define functional coverage using cover groups, cover points, bins and cross coverage and measure coverage closure. **Learning Outcome:** Students will be able to write functional coverage and interpret coverage reports to guide verification.
10	**Assertion-Based Verification Mini-Project** **Learning Objective:** To implement an end-to-end verification environment for a digital block using SystemVerilog Assertions and a self-checking testbench. **Learning Outcome:** Students will be able to integrate stimulus, checking, coverage and assertions into a complete verification flow.

Text Books:

1. Eduard Cerny, Surrendra Dudani, John Havlicek, Dmitry Korchemny, SVA: The Power of Assertions in SystemVerilog Second Edition, Springer.
2. Chris Spear and Greg Tumbush, "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features", Springer, 3rd Edition.
3. Stuart Sutherland, Simon Davidmann and Peter Flake, "SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling", Springer, 2nd Edition.
4. Lionel Bening and Harry Foster, "Principles of Verifiable RTL Design", Kluwer Academic / Springer, 2nd Edition.

Reference Books:

1. Samir Palnitkar, *"Verilog HDL: A Guide to Digital Design and Synthesis"*, Pearson Education, 2nd Edition.
2. Frank Vahid, *"Digital Design with RTL Design, Verilog and VHDL"*, Wiley, 2nd Edition.
3. Ashok B. Mehta, *"SystemVerilog Assertions and Functional Coverage: Guide to Languages, Methodology and Applications"*, Springer, 3rd Edition.
4. Janick Bergeron, *"Writing Testbenches using SystemVerilog"*, Springer.

Useful Links:

1. NPTEL–Hardware Modeling using Verilog (IIT Kharagpur): https://onlinecourses.nptel.ac.in/noc23_cs76/preview
2. NPTEL – Digital VLSI Design / RTL flow (IIT Kharagpur): https://nptel.ac.in/courses/106105165
3. Siemens Verification Academy – SystemVerilog & UVM: https://verificationacademy.com
4. ChipVerify – SystemVerilog and Verification tutorials: https://www.chipverify.com
5. EDA Playground – online Verilog/SystemVerilog simulator: https://www.edaplayground.com

Virtual Lab Links:

1. VLSI / Digital Design Virtual Lab (IIT): http://vlsi-iitg.vlabs.ac.in/

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Journal/Mini Project/Case Study = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 10 experiments.
Oral (25 Marks)	Oral examination will be based on the experiments performed by the students during laboratory sessions and the syllabus.

Course Vertical 3- Multidisciplinary Minor (MDM): Total Credits: 04

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25CE5MDM02	Android Application Development	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25

Pre-Requisite Courses:	25FEAEC01: JAVA Programming

Course and Module Overview:

This course is designed to introduce Mechanical and Electronics Engineering students to the fundamentals of Android application development. Offered by the Department of Computer Engineering, it provides a structured, beginner-friendly pathway to understanding the mobile application ecosystem, development tools, and core programming concepts needed to build functional Android apps.

The course focuses on hands-on learning through six progressively structured modules, starting from environment setup and basic UI design, to data management, background services, and networked applications. Students will gain practical experience through a minimum of twelve laboratory sessions covering real-world development scenarios.

The curriculum is kept intentionally broad to ensure accessibility for students from non-software backgrounds, while still delivering industry-relevant skills. On completing this course, students will be capable of independently developing, testing, and deploying simple Android applications, and will have a strong foundation for further exploration of mobile development in their respective engineering domains.

Module 1 – Introduction to Android

This module builds the foundational knowledge required to begin Android development. Students will explore the history and growth of the Android ecosystem, understand the overall architecture of Android applications, and learn to configure the development environment including Android Studio and the SDK. The module covers project structure, the Android Manifest file, running apps on virtual and physical devices, and the Activity lifecycle. The SOLID design principles are also introduced to encourage good software design habits from the outset.

Module 2 – Android UI Fundamentals

This module focuses on designing and building effective user interfaces using Android's XML-based layout system. Students will work with the most commonly used UI components including TextView, EditText, Button, and ImageView, and will learn to structure screens using LinearLayout, RelativeLayout, and ConstraintLayout. Topics also include handling screen orientation changes, using the action bar, displaying Toast notifications, and applying basic UI design principles to build clean and intuitive interfaces.

Module 3 – Activities, Intents & Fragments

This module explores the structural building blocks of Android applications. Students will develop a thorough understanding of the Activity lifecycle and learn to navigate between screens using explicit and implicit Intents. Intent filters and data passing between activities are covered in detail. The module also introduces Fragments, their lifecycle, management, and use in building flexible multi-screen applications, giving students the skills needed to construct well-structured, navigable apps.

Module 4 – Data Storage

This module equips students with the techniques needed to persist data within Android applications. Topics include SharedPreferences for storing small key-value data, reading and writing to internal device storage, and creating and managing a SQLite relational database through direct SQL operations and the higher-level Room Persistence Library. Students will implement basic Create, Read, Update, and Delete (CRUD) operations and understand when to apply each storage mechanism based on the nature and volume of the data.

Module 5 – Android Services & Notifications

This module introduces the mechanisms Android provides for running operations in the background and communicating with the user. Students will learn about the Service lifecycle, implement Broadcast Receivers to respond to system and app-level events, and use NotificationManager to deliver alerts and updates. The module also covers scheduling tasks with AlarmManager, sending emails via Intent, and managing user alerts, skills essential for building responsive and professionally polished applications.

Module 6 – Networking & Multimedia

This module introduces students to connecting Android applications to the internet and handling rich media content. Topics include making HTTP requests to web servers, parsing JSON responses, and using the Retrofit library for efficient API consumption. Students will also explore Android's Media APIs to integrate audio and video playback into their apps. The module concludes with an overview of the AndroidX libraries and an introduction to RESTful web service integration, preparing students for building data-driven, connected applications.

Course Outcomes (COs)	**After successful completion of the course, the students will be able to:**	
	CO1	Understand the Android ecosystem, architecture, and set up a development environment to build and run basic Android applications. (Remember)
	CO2	Design and implement user interfaces using XML layouts and standard UI components including TextView, EditText, Button, and ImageView. (Understand)
	CO3	Apply Activity lifecycle concepts, use explicit and implicit Intents, and build multi-screen applications using Fragments. (Apply)
	CO4	Implement data storage mechanisms using Shared Preferences, internal file storage, and SQLite database for data persistence. (Analyze)
	CO5	Understand and apply Android services, broadcast receivers, notification services, and alarm management in applications. (Evaluate)
	CO6	Integrate networking features to consume web services, parse JSON data, and use multimedia APIs for audio/video playback. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Android**	07
		After completing this module, students will be able to: • Understand Android ecosystem and evolution • Explain Android architecture and components • Set up Android development environment • Apply SOLID principles in development	
	1.1	**Android Ecosystem Overview:** Devices, OS layers, Play Store ecosystem, Open-source nature	
	1.2	**History & Versions:** Evolution timeline, major releases, feature improvements, API levels	
	1.3	**Development Setup:** Android Studio installation, SDK configuration, Emulator setup, Running Hello World	
	1.4	**Project Structure & Architecture:** Manifest file, Project folders, AAC components, Activity lifecycle basics	
		Self-Learning Topics: Explore latest Android version features; Compare Android with other mobile OS; Install Android Studio and document steps.	
2		**Android UI Fundamental**	08
		After completing this module, students will be able to: • Design UI using XML layouts • Use common UI components • Handle screen orientation • Implement user interaction feedback	
	2.1	**XML Layout Design:** Layout structure, View hierarchy, Attributes, UI rendering	
	2.2	**UI Components:** TextView, EditText, Button, ImageView properties and usage	
	2.3	**Layout Types:** Linear Layout, Relative Layout, Constraint Layout, Use cases	
	2.4	**UI Interaction:** Orientation changes, Action bar, Toast messages, Basic notifications	
		Self-Learning Topics: Design sample mobile app screens; Create responsive layouts.	
3		**Activities, Intents & Fragments**	08
		After completing this module, students will be able to: derstand activity lifecycle intents for communication	

	• Implement fragments • Design multi-screen apps		
	3.1	**Activity Lifecycle:** States, transitions, callbacks, lifecycle management	
	3.2	**Intents:** Explicit, implicit, intent filters, data passing.	
	3.3	**Application Flow:** Multi-screen navigation, back stack, UI transitions	
	3.4	**Fragment Communication:** Passing data between fragments, fragment-to-activity interaction, ViewModel usage basics	
	Self-Learning Topics: Implement fragment-based UI.		
4	**Data Storage**		**08**
	After completing this module, students will be able to: • Store and retrieve data • Use lightweight storage methods • Perform database operations • Implement persistence techniques.		
	4.1	**Shared Preferences:** Key-value storage, reading/writing data, use cases	
	4.2	**Internal Storage:** File handling, read/write operations, security aspects	
	4.3	**SQLite Database:** Database creation, CRUD operations, queries	
	4.4	**Room Library:** ORM concepts, advantages, entity and DAO basics	
	Self-Learning Topics: Develop small data storage app; Compare SQLite and Room		
5	**Android Services & Notifications**		**08**
	After completing this module, students will be able to: • Understand background processing • Use services and receivers • Implement notifications • Handle user alerts		
	5.1	**Android Services:** Types, lifecycle, background execution, use cases	
	5.2	**Broadcast Receivers:** Event handling, system broadcasts, custom broadcasts.	
	5.3	**Notifications:** Notification manager, alerts, alarm services, user interaction	
	5.4	**Intent-based Communication:** Sending emails, implicit intents, external apps interaction	
	Self-Learning Topics: Explore background task handling.		
6	**Networking & Multimedia Basics**		**06**

	After completing this module, students will be able to: • Consume web services • Handle JSON data • Use networking libraries • Work with multimedia APIs		
	6.1	**Networking Basics:** HTTP methods, API calls, connectivity handling	
	6.2	**JSON Processing:** Parsing techniques, data mapping, error handling	
	6.3	**Retrofit Library:** Setup, API integration, advantages	
	6.4	**Multimedia:** Audio/video playback, media APIs, AndroidX libraries overview	
	Self-Learning Topics: Create API-based app; Integrate media playback.		
	Total		**45**

Suggested List of Experiments:

Experiment/ Task No.	Title of the Experiment/ Task
1	**To set up Android Studio and create a basic Android application.** **Learning Objective:** • Install Android Studio and configure emulator • Create and run a Hello World application • Understand project structure and Manifest file • View log statements using Logcat **Learning Outcome:** Students will be able to set up Android environment and execute a basic application successfully.
2	**To develop a basic interactive UI application using layouts and button events.** **Learning Objective:** • Display Toast message on button clicks • Explore Linear Layout, Relative Layout, Constraint Layout • Handle basic UI interactions **Learning Outcome:** Students will be able to create interactive UI applications with event handling.
3	**To design a user input form and transfer data between activities.** **Learning Objective:** • Create form with multiple input fields • Collect user details (name, email, etc.) • Pass data using Explicit Intent **Learning Outcome:** Students will be able to design forms and implement activity-to-activity communication.
4	**To implement implicit intents and intent filters in Android.** **Learning Objective:** • Open web pages using implicit intents • Launch Google Maps using location intent • Implement intent filters for activity access **Learning Outcome:** Students will be able to use system-level apps through implicit intents.
5	**To implement various input controls and picker dialogs.** **Learning Objective:** • Use Spinner for dropdown selection • Implement AlertDialog with actions • Use DatePicker and TimePicker dialogs **Learning Outcome:** Students will be able to integrate advanced input components in Android apps.
6	**To implement menus, selection controls, and navigation.** **Learning Objective:** • Create Options/Overflow menu • Handle menu item selection • Use Radio Buttons for choices • Implement Up navigation in App Bar

	Learning Outcome: Students will be able to design structured navigation and selection interfaces.
7	**To apply themes, styles, and custom drawable resources in Android.** **Learning Objective:** • Create custom themes and styles • Apply reusable UI styling • Use drawable resources in UI design **Learning Outcome:** Students will be able to enhance UI consistency using themes and styles.
8	**To implement user preferences using Shared Preferences and settings screen.** **Learning Objective:** • Create Settings screen using Preference Fragment Compat • Store and retrieve user preferences • Apply preferences at runtime **Learning Outcome:** Students will be able to manage user settings and persistent preferences.
9	**To develop a CRUD-based Notes application using SQLite database.** **Learning Objective:** • Perform insert, update, delete, and read operations • Store notes in SQLite database • Display data using RecyclerView **Learning Outcome:** Students will be able to implement database-driven applications with CRUD operations
10	**To perform background processing using AsyncTask or WorkManager.** **Learning Objective:** • Create background tasks • Update UI after task completion • Understand threading concepts **Learning Outcome:** Students will be able to execute background operations in Android applications.

Text Books:

1. Wei Meng Lee – Beginning Android 4 Application Development, Wrox Publication.

Reference Books:

1. Joseph Annuzzi, Lauren Darcey, Shane Conder – Advanced Android Application Development, 4th Edition, Pearson.
2. John Horton – Android Programming for Beginners, 3rd Edition, Packt Publication.
3. Pradeep Kothari – Android Application Development Black Book, DreamTech.

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25IT5MDM02	Database Management System	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25

Pre-Requisite Courses:	25FE1VESC02 - Problem Solving using C programming
	25FE2PCC04 - Data structure and algorithm

Course and Module Overview:

The Database Management System (DBMS) course provides a comprehensive understanding of modern data management principles, database design methodologies, and relational database technologies. Students learn to model real-world applications using ER/EER diagrams, design normalized databases, formulate and optimize SQL queries, and understand transaction processing, concurrency control, and recovery mechanisms. The course also introduces database programming using JDBC and exposes learners to emerging schema-less NoSQL databases, enabling them to build efficient, scalable, and reliable data-driven applications

Module Overview

Module 1: Introduction to Database Management Systems

This module introduces the fundamental concepts of database systems, highlighting the limitations of traditional file processing systems and the advantages offered by DBMS. Students gain an understanding of database architectures, different types of databases, and the roles of various database users, forming the foundation for advanced database concepts.

Module 2: Data Modeling, Database Design and Normalization

This module focuses on conceptual and logical database design techniques. Students learn to develop ER/EER models, transform them into relational schemas, and apply normalization techniques to eliminate redundancy and maintain data consistency. Real-world case studies help learners understand practical database design considerations.

Module 3: SQL and Relational Algebra

This module develops proficiency in SQL for creating, manipulating, and querying databases. It covers SQL commands, aggregate operations, joins, views, stored procedures, triggers, and introduces relational algebra operations that provide the theoretical basis for relational query processing

Module 4: Transaction Processing, Concurrency and Database Recovery

This module explains the mechanisms that ensure reliable and consistent database operations in multi-user environments. Students study transaction properties, scheduling techniques, concurrency control protocols, deadlock handling, and recovery methods that preserve data integrity during failures.

Module 5: Database Programming

This module introduces database connectivity and application-level database interactions. Students learn to establish database connections, execute queries, manage records, and implement CRUD operations using JDBC and Java, enabling the development of database-driven applications.

Module 6: Introduction to Schema-less Databases

This module provides an overview of NoSQL databases and schema-less data models. Students explore the differences between SQL and NoSQL systems, understand their advantages and limitations, and perform basic operations using MongoDB, preparing them for modern large-scale data management environments.

The Database Management System (DBMS) course provides students with a strong foundation in database concepts, design methodologies, and relational database technologies. It enables learners to model, design, query, and manage databases efficiently using SQL, normalization techniques, and transaction management concepts. The course also introduces database programming with JDBC and modern NoSQL databases to support the development of scalable and data-driven applications

Course Outcomes (COs)	**After successful completion of the course, the students will be able to:**	
	CO1	Recall fundamental concepts and architectural details related to database management systems. (Remember)
	CO2	Explain the fundamental concepts, steps, and techniques involved in database design, query processing and transaction processing. (Understand)
	CO3	Apply SQL commands to define, manipulate, and retrieve data using various database objects for effective information storage and processing. (Apply)
	CO4	Analyze real-world system requirements to construct and optimize database design for consistency and efficiency. (Analyze)
	CO5	Evaluate database design and identify appropriate techniques for efficient information management/processing. (Evaluate)
	CO6	Design and implement a normalized relational database to perform database transaction operations effectively. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1			04
	After completing this module, students will be able to: • Explain the need for DBMS and its advantages over traditional file systems. • Describe database architectures, types, and user roles. • Differentiate among various database models and application domains.		
	1.1	Introduction to DBMS, Advantages over file system, Database terminology and characteristics.	
	1.2	Database architecture, 3-level architecture, Database types and Database Users.	
	Self-Learning Topics: Case Study based on Amazon Database.		
2	**Data Modeling, Database Design and Normalization**		12
	After completing this module, students will be able to: • Develop ER/EER diagrams for real-world applications. • Transform conceptual models into relational schemas. • Apply normalization techniques to minimize redundancy and maintain data integrity.		
	2.1	Data modeling and models, E-R Modeling: Entities, Attributes, Relationships, Cardinality, Participation, ER diagrams, Limitations, Relational Modeling, Converting ER model to Relational model.	
	2.2	Extended Entity Relationship (EER), Generalization, Specialization and Association.	
	2.3	Case studies based on ER model (real life examples e.g. Amazon, Spotify, Swiggy, LinkedIn, IRCTC, etc.)	
	2.4	Database Anomalies, Normalization process, Advantages, Functional dependencies (Full, Partial and Transitive), Normal forms: 1NF, 2NF and 3NF.	
	Self-Learning Topics: BCNF and Normal forms-based problems.		
3	**SQL and Relational Algebra**		11
	After completing this module, students will be able to: • Use SQL commands to define, manipulate, and query database objects. • Implement advanced SQL features such as views, procedures, functions, and triggers. • Apply relational algebra operations to formulate and analyze database queries.		
	3.1	SQL basics - datatypes, operators, integrity constraints; SQL commands - DDL, DML, DCL, Aggregate functions, Group By, Order By, Subqueries	

		and SQL JOINs.	
	3.2	Advance SQL – Virtual Tables (Views), Stored Procedures, Functions and Triggers	
	3.3	Relational Algebra: Union, Selection, Projection, Cartesian Product, Joins	
	Self-Learning Topics: Set Operations.		
4	**Transactions Processing, Concurrency and Database Recovery**		**11**
	After completing this module, students will be able to: • Explain transaction properties and scheduling concepts in DBMS. • Analyze concurrency control techniques and deadlock handling mechanisms. • Evaluate database recovery methods to ensure consistency and reliability.		
	4.1	Database transaction, ACID properties, Transaction states diagram, TCL (Commit, Rollback, Savepoints), Schedules, Serializability.	
	4.2	Database recovery mechanism - Lag based, Checkpoints and shadow paging; Deadlock detection and prevention	
	4.3	Concurrency control techniques - Locking, Timestamping and Validation protocol.	
	Self-Learning Topics: DeadLock prevention and detection.		
5	**Database programming**		**04**
	After completing this module, students will be able to: • Establish database connectivity using JDBC. • Perform CRUD operations through database applications. • Develop simple database-driven applications using Java and MySQL.		
	5.1	Database driver and connection string, Cursor, RecordSets, Default query and Parameterized query.	
	5.2	Database programming with JDBC – CRUD Operations with Java and MySQL	
	Self-Learning Topics: Domain specific database and UI design.		
6	**Introduction to Schema-less Database**		**03**
	After completing this module, students will be able to: • Compare schema-based and schema-less database systems. • Explain the features, benefits, and limitations of NoSQL databases. • Perform basic data operations using MongoDB and understand its application scenarios.		
	6.1	Schema vs. Schema-less databases. Advantages and disadvantages	
	6.2	Schema-less database (NoSQL) features, SQL vs NoSQL, and MongoDB Basic Operations	

	Self-Learning Topics: Installation and query processing with Cassendra.	
	Total	**45**

Suggested List of Experiments:

Experiment/ Task No.	Title of the Experiment/ Task
1	**Draw an ER diagram and convert it into relational schema for a real life problem.** **Learning Objective:** To understand conceptual database design by modeling real-world entities, relationships, and constraints using ER diagrams and converting them into relational schemas. **Learning Outcome:** Students will be able to design ER diagrams for real-world applications and transform them into well-structured relational database schemas.
2	**Perform SQL DDL commands with various Constraints.** **Learning Objective:** To learn the use of SQL Data Definition Language (DDL) commands and integrity constraints for creating and managing database objects. **Learning Outcome:** Students will be able to create, modify, and manage database structures while enforcing data integrity using appropriate constraints.
3	**Perform SQL DML commands with Where clause and various Operators.** **Learning Objective:** To develop proficiency in manipulating database records using SQL DML statements and filtering data using conditions and operators. **Learning Outcome:** Students will be able to insert, update, delete, and retrieve data efficiently by applying suitable filtering conditions and operators.
4	**Execute Aggregate functions, Group By and Subqueries.** **Learning Objective:** To understand advanced query formulation techniques for data summarization, grouping, and nested query execution. **Learning Outcome:** Students will be able to analyze and summarize database information using aggregate functions, grouping mechanisms, and subqueries.
5	**Perform various types of SQL JOINs.** **Learning Objective:** To understand methods for retrieving related data from multiple tables using different SQL join operations. **Learning Outcome:** Students will be able to combine and query data from multiple relations using appropriate join techniques.
6	**Create SQL VIEWs and Indexing.** **Learning Objective:** To explore database abstraction and query optimization techniques through views and indexing mechanisms. **Learning Outcome:** Students will be able to create virtual tables and implement indexing strategies to enhance database security and query performance.
7	**Create SQL Procedure and Trigger for the given scenario.** **Learning Objective:** To understand procedural extensions of SQL and automate database operations using stored procedures and triggers. **Learning Outcome:** Students will be able to design and implement stored procedures

	and triggers to support business logic and automated database actions.
8	**Perform CRUD operations using JDBC API.** **Learning Objective:** To learn database connectivity and application-level interaction using the JDBC API for executing SQL operations. **Learning Outcome:** Students will be able to develop Java-based applications that perform Create, Read, Update, and Delete (CRUD) operations on relational databases.
9	**Simulate transaction control using TCL (Commit, Rollback, Savepoint).** **Learning Objective:** To understand transaction management concepts and control mechanisms that ensures consistency and reliability in database operations. **Learning Outcome:** Students will be able to implement transaction control commands to maintain database integrity during concurrent and multi-step operations.
10	**Perform DCL - New Users, Roles, and Privileges (Revoke and Grant).** **Learning Objective:** To learn database security concepts by managing user access, privileges, and roles using Data Control Language (DCL) commands. **Learning Outcome:** Students will be able to administer database security by creating users, assigning roles, and controlling access permissions effectively.
Self-Study	**Concurrency simulation**

Textbooks:

1. Database System Concepts – Abraham Silberschatz, Henry Korth, and S. Sudarshan (7th Edition, McGraw Hill)
2. Fundamentals of Database Systems – RamezElmasri and ShamkantNavathe (6th Edition, Pearson)

References:

1. SQL For Dummies – Allen G. Taylor (Wiley).
2. SQL in 10 Minutes, Sams Teach Yourself by Ben Forta.
3. Principles of Distributed Database Systems – M. Tamer Özsu and Patrick Valduriez.
4. NoSQL Distilled – Pramod J. Sadalage, Martin Fowler (Addison-Wesley).

Online Platforms:

1. MIT OpenCourseWare - https://ocw.mit.edu/courses/6-830-database-systems-fall-2010/pages/readings/.
2. NPTEL - https://onlinecourses.nptel.ac.in/noc22_cs91/preview.
3. CoursEra - https://www.coursera.org/learn/database-management.
4. IBM/Edx - https://www.edx.org/certificates/professional-certificate/ibm-sql-nosql-and-relational-database-fundamentals.

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5MDM01	Quality Engineering	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25

Pre-Requisite Courses:	NIL

Course and Module Overview:

Quality Engineering introduces the principles, tools, and techniques used to achieve and sustain quality in products, processes, and services. The course covers Total Quality Management (TQM), Statistical Quality Control (SQC), Reliability Engineering, Quality Function Deployment (QFD), Lean Six Sigma, and Quality Management Systems. It emphasizes continuous improvement, customer satisfaction, process optimization, and reliability in manufacturing, software, IT, and communication systems.

Module Overview

Module 1: Total Quality Management (TQM)

This module introduces the concepts, principles, and philosophies of Total Quality Management. It focuses on customer satisfaction, continuous improvement, quality costs, and the contributions of leading quality gurus in achieving organizational excellence.

Module 2: Statistical Quality Control and Process Capability

This module covers statistical techniques used for monitoring and controlling process quality. It includes control charts, process capability analysis, and applications of statistical quality control in manufacturing, software, and electronic systems.

Module 3: Acceptance Sampling and Reliability Engineering

This module introduces acceptance sampling methods and reliability concepts used to evaluate product quality and system performance. It also covers reliability analysis of engineering systems and their applications across different domains.

Module 4: Quality Improvement Tools and Techniques

This module focuses on the practical tools used for quality improvement and problem-solving. Students learn the seven basic quality tools, root cause analysis, Kaizen, 5S, and Poka-Yoke techniques for continuous process improvement.

Module 5: Design for Quality and Quality Function Deployment

This module emphasizes customer-focused product and service development. It covers Voice of Customer (VOC), Quality Function Deployment (QFD), House of Quality, and design approaches that improve quality during product development.

Module 6: Lean Six Sigma and Quality Management Systems

This module introduces modern quality improvement methodologies such as Lean Manufacturing and Six Sigma. It also covers ISO 9001 Quality Management Systems, quality audits, and best practices for achieving operational excellence and continuous improvement.

	After successful completion of the course, the students will be able to:	
Course Outcomes (COs)	CO1	Recall the fundamental concepts, philosophies, and terminology associated with quality engineering and TQM. (Remember)
	CO2	Explain quality management principles, statistical quality control techniques, and quality improvement methodologies. (Understand)
	CO3	Apply quality engineering tools for process monitoring, process capability analysis, reliability assessment, and quality improvement. (Applye)
	CO4	Analyze process performance, quality problems, customer requirements, and system reliability using appropriate quality techniques. (Analyze)
	CO5	Evaluate manufacturing, software, IT service, and communication system processes using quality engineering principles and improvement methodologies. (Evaluate)
	CO6	Develop quality-focused solutions using TQM, QFD, Lean Six Sigma, reliability engineering, and quality management systems. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Total Quality Management**		08
	After completing this module, students will be able to: • Explain the fundamental concepts, principles, and philosophies of Total Quality Management and the contributions of quality gurus. • Describe the role of customer satisfaction, quality costs, and continuous improvement in achieving organizational excellence		
	1.1	Evolution and importance of quality. Dimensions of quality in products and services. Contributions of Deming, Juran, Crosby, Ishikawa, and Taguchi. Principles of Total Quality Management.	
	1.2	Customer focus and customer satisfaction. Employee involvement and teamwork. Continuous improvement philosophy.	
	1.3	Cost of Quality. Applications of TQM in manufacturing, software industries, IT services, and telecom sectors.	
	Self-Learning Topics: Study of Quality Management Practices in a Leading Organization (e.g., Toyota, Tata Motors, Infosys, TCS, Samsung, etc.)		
2	**Statistical Quality Control and Process Capability**		08
	After completing this module, students will be able to: • Explain process variation and the application of control charts for monitoring process performance. • Calculate and interpret process capability indices for assessing process quality and performance.		
	2.1	Process variation and quality characteristics. Statistical concepts for quality control.	
	2.2	Control Charts: $\bar{X}$ Chart, R Chart, p Chart, np Chart, c Chart, u Chart Process Capability Analysis. Process Capability Indices (Cp and Cpk).	
	2.3	Applications of SPC in manufacturing, software defect monitoring, network performance monitoring, and electronics manufacturing.	
	Self-Learning Topics: Applications of Statistical Process Control (SPC) in Manufacturing, Software Development, and Network Performance Monitoring.		
3	**Acceptance Sampling and Reliability Engineering**		

	After completing this module, students will be able to: • Apply acceptance sampling concepts and OC curves for quality inspection and decision-making. • Analyze the reliability characteristics of engineering systems using reliability concepts and models.		**07**
	3.1	Fundamentals of acceptance sampling. Single sampling plans. Producer's Risk and Consumer's Risk. Operating Characteristic (OC) Curve.	
	3.2	Reliability concepts and terminology. Failure rate and reliability function. Bath Tub Curve. Reliability of series and parallel systems. Reliability applications in mechanical systems, computer hardware, communication systems, and embedded systems.	
	Self-Learning Topics: Reliability Analysis of Consumer Products, Computer Hardware, and Communication Systems.		
4	**Quality Improvement Tools and Techniques**		**08**
	After completing this module, students will be able to: • Utilize basic quality tools to identify and investigate quality-related problems. • Analyze process improvement opportunities using root cause analysis, Kaizen, 5S, and Poka-Yoke techniques.		
	4.1	Seven Basic Quality Tools: Check Sheet Histogram Pareto Chart Cause-and-Effect Diagram Scatter Diagram Control Chart Flow Chart	
	4.2	Root Cause Analysis. Kaizen. 5S Methodology. Poka-Yoke (Mistake Proofing). Applications in manufacturing, software quality improvement, IT services, and electronics industries.	
	Self-Learning Topics: Case Study on the Implementation of Kaizen, 5S, or Poka-Yoke in Industrial or Service Organizations.		
5	**Design for Quality and Quality Function Deployment**		**07**
	After completing this module, students will be able to:		

	• Explain customer requirements and the methodology of Quality Function Deployment (QFD). • Analyze customer needs and translate them into engineering specifications using the House of Quality.		
	5.1	Voice of Customer (VOC). Customer requirements and expectations. Quality Function Deployment (QFD). House of Quality.	
	5.2	Design for Manufacturability (DFM). Design for Assembly (DFA). Taguchi Quality Loss Function. Applications in product design, software development, consumer electronics, and communication devices.	
	Self-Learning Topics: Development of a House of Quality (QFD) for a Product, Mobile Application, or Service System.		
6	**Lean Six Sigma and Quality Management Systems**		**07**
	After completing this module, students will be able to: • Analyze equipment performance using reliability, availability, maintainability, MTBF, and MTTR concepts. • Examine modern maintenance management practices such as TPM, CMMS, Industry 4.0, and predictive maintenance.		
	6.1	Lean Manufacturing concepts. Waste identification and elimination. Introduction to Six Sigma. DMAIC Methodology. Quality Management Systems (QMS).	
	6.2	ISO 9001 requirements and documentation. Quality Audits. Quality practices in manufacturing, software quality assurance, IT services, and telecom industries.	
	Self-Learning Topics: Case Study on Lean Six Sigma and ISO 9001 Implementation in Manufacturing, IT, or Telecom Industries.		
	Total		**45**

Suggested List of Experiments/Tasks:

Experiment/ Task No.	Title of the Experiment/ Task
1	**Study of Quality Dimensions and Quality Costs Using Industrial Case Studies.** **Learning Objective:** To understand the dimensions of quality and the impact of quality costs on organizational performance. **Learning Outcome:** Students will be able to identify quality dimensions and classify quality costs in industrial applications.
2	**Analysis of Quality Philosophies of Deming, Juran, Crosby, Ishikawa, and Taguchi.** **Learning Objective:** To study the contributions of quality gurus and their role in quality management practices. **Learning Outcome:** Students will be able to explain and compare various quality philosophies for organizational excellence.
3	**Construction and Interpretation of $\bar{X}$ and R Control Charts.** **Learning Objective:** To learn the application of variable control charts for monitoring process performance. **Learning Outcome:** Students will be able to construct and interpret $\bar{X}$ and R control charts for process control.
4	**Machinery Servicing (Greasing, Oiling, Cleaning, Inspection).** **Learning Objective:** To understand routine servicing procedures required for efficient machine operation. **Learning Outcome:** Students will be able to perform basic machine servicing activities and assess their importance in preventive maintenance.
5	**Construction of Attribute Control Charts (p, np, c and u Charts)** **Learning Objective:** To understand the use of attribute control charts for quality monitoring and analysis. **Learning Outcome:** Students will be able to select and apply appropriate attribute control charts for different quality characteristics.
6	**Design of Acceptance Sampling Plans and OC Curve Analysis.** **Learning Objective:** To study acceptance sampling techniques used in quality inspection and decision-making. **Learning Outcome:** Students will be able to design sampling plans and analyze OC curves for quality acceptance decisions.
7	**Reliability Analysis of Series and Parallel Systems.** **Learning Objective:** To understand reliability concepts and methods for evaluating system reliability. **Learning Outcome:** Students will be able to determine the reliability of simple engineering systems and configurations.
8	**Application of Pareto Analysis and Cause-and-Effect Diagrams for Problem Solving.** **Learning Objective:** To identify and analyse major causes of quality problems using

	basic quality tools. **Learning Outcome:** Students will be able to perform root cause analysis and prioritize corrective actions.
9	**Implementation Study of 5S and Kaizen in Manufacturing or Service Systems.** **Learning Objective:** To understand the principles of workplace organization and continuous improvement. **Learning Outcome:** Students will be able to apply 5S and Kaizen methodologies for process and workplace improvement.
10	**Development of a House of Quality (QFD) for a Selected Product or Service.** **Learning Objective:** To translate customer requirements into engineering specifications using QFD. **Learning Outcome:** Students will be able to develop a House of Quality for customer-focused product or service design.
11	**Lean Waste Identification and Six Sigma DMAIC Case Study.** **Learning Objective:** To study Lean and Six Sigma methodologies for quality and process improvement. **Learning Outcome:** Students will be able to identify process waste and apply DMAIC methodology to solve quality-related problems.
12	**Mini Project on Quality Improvement for a Manufacturing Process, Software Application, IT Service, or Communication System.** **Learning Objective:** To integrate quality engineering tools and techniques for solving real-world quality challenges**.** **Learning Outcome:** Students will be able to develop and present a quality improvement solution using appropriate quality engineering methodologies.

Text Books:

1. Total Quality Management – N. V. R. Naidu and K. M. Babu, New Age International Publishers, Latest Edition.
2. Statistical Quality Control – M. Mahajan, Dhanpat Rai Publications, Latest Edition.
3. Quality Planning and Analysis – J. M. Juran and F. M. Gryna, McGraw Hill Education, 5th Edition.

Reference Books:

5. Total Quality Management – Dale H. Besterfield, Pearson Education, 4th Edition.
6. Introduction to Statistical Quality Control – Douglas C. Montgomery, Wiley India, 8th Edition.
7. Quality Engineering Using Robust Design – Madhav S. Phadke, Pearson Education, Latest Edition.
8. Managing for Total Quality – N. V. R. Naidu and K. M. Babu, New Age International Publishers, Latest Edition.
9. Reliability Engineering – E. Balagurusamy, Tata McGraw Hill, Latest Edition.
10. The Certified Quality Engineer Handbook – Connie M. Borror, ASQ Quality Press, 5th Edition.

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ME5MDM02	Industrial Automation	L	P	T	L	P	T	Total
		3	2	-	3	1	-	4
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	20	30	50	-	-	-	100
		Lab	-	-	-	25	-	-	25

Pre-Requisite Courses:	NIL

Course and Module Overview:

Industrial Automation focuses on the technologies and systems used to automate manufacturing and industrial processes for improved productivity, quality, flexibility, and safety. The course covers automation fundamentals, sensors and actuators, programmable controllers, CNC and flexible manufacturing systems, Product Lifecycle Management (PLM), SCADA systems, Cyber-Physical Systems (CPS), and Industrial Internet of Things (IIoT). Students gain an understanding of modern automation technologies used in smart factories and Industry 4.0 environments.

Module Overview

Module 1: Introduction to Automation in Industry

This module introduces the basic concepts of industrial automation and manufacturing system organization. It covers mechanization, automated production systems, and group technology concepts used for improving manufacturing efficiency.

Module 2: Sensors, Actuators and Controllers

This module introduces sensing and actuation devices used in automated systems. It also provides basic knowledge of PLCs and microcontrollers used for process monitoring and control.

Module 3: Levels of Automation

This module focuses on different levels of manufacturing automation ranging from NC machines to CIM. It introduces flexible manufacturing concepts and integrated production systems.

Module 4: Product Lifecycle Management

This module introduces PLM concepts and their role in managing products throughout their lifecycle. It also covers quality and lean manufacturing tools used for process improvement.

Module 5: SCADA Systems

This module introduces SCADA systems used for industrial monitoring and control. Students learn about system architecture, communication networks, HMI, and supervisory control applications.

Module 6: CPS and Industrial Internet of Things (IIoT)

This module introduces Industry 4.0 technologies including CPS, IIoT, Digital Twins, cloud-based monitoring, and intelligent maintenance systems used in smart manufacturing environments.

Course Outcomes (COs)	**After successful completion of the course, the students will be able to:**	
	CO1	Recall the fundamental concepts, terminology, and technologies used in industrial automation systems. (Remember)
	CO2	Explain the principles and functions of automation components, manufacturing systems, and industrial control technologies. (Understand)
	CO3	Apply automation tools and technologies such as PLCs, CNC systems, SCADA, and IIoT for industrial applications. (Apply)
	CO4	Analyze automated manufacturing systems, control architectures, and industrial communication networks for improved productivity. (Analyze)
	CO5	Evaluate suitable automation solutions and Industry 4.0 technologies for specific industrial applications. (Evaluate)
	CO6	Develop basic automation strategies integrating sensors, controllers, SCADA, and IIoT technologies for smart manufacturing systems. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Automation in Industry**	07
		After completing this module, students will be able to: • Explain the concepts of mechanization, automation, and material handling systems used in manufacturing industries. • Describe group technology, part families, and classification techniques used in production planning.	
	1.1	Mechanization and Automation. Material Handling Systems. Hard Automation and Transfer Lines.	
	1.2	Group Technology. Part Families. Part Classification and Coding.	
		Self-Learning Topics: Applications of Automation in Automotive, Electronics, and Process Industries.	
2		**Sensors, Actuators and Controllers**	07
		After completing this module, students will be able to: • Explain the operating principles and applications of industrial sensors and actuators. • Describe the architecture and functions of PLCs and microcontrollers used in automation systems.	
	2.1	Touch and Non-Touch Sensors. Digital and Analog Sensors. Linear and Rotary Actuators.	
	2.2	Fluid Power and Electrical Actuators. Introduction to PLC. Microcontroller Architecture and Modules.	
		Self-Learning Topics Emerging Smart Sensors and Industrial Microcontroller Applications.	
3		**Levels of Automation**	07
		After completing this module, students will be able to: • Explain the working principles of NC, CNC, and DNC systems used in automated manufacturing. • Analyze the role of FMS and CIM in achieving manufacturing flexibility and productivity.	
	3.1	NC, CNC and DNC Systems. CNC Machining (3-Axis).	

	3.2	Flexible Manufacturing Systems (FMS). FMS Components, Layouts and Equipment. Introduction to Computer Integrated Manufacturing (CIM).	
	Self-Learning Topics: Smart Manufacturing and Industry 4.0 Applications in CNC-Based Production Systems.		
4	**Product Lifecycle Management (PLM)**		**08**
	After completing this module, students will be able to: • Explain the phases and benefits of Product Lifecycle Management in modern industries. • Apply lean and quality improvement concepts such as Kanban, JIT, and Ishikawa techniques for process optimization.		
	4.1	Product Lifecycle Management Concepts. Key Phases of PLM. Benefits of PLM.	
	4.2	Kanban System. Just-in-Time (JIT). Ishikawa and Juran Quality Techniques. Introduction to PLM Software Tools (SAP and Similar Platforms).	
	Self-Learning Topics: Case Study of PLM Implementation in Manufacturing Organizations.		
5	**SCADA Systems**		**08**
	After completing this module, students will be able to: • Explain the architecture and components of SCADA systems used in industrial automation. • Analyze the role of PLC integration, HMI, and communication networks in remote monitoring and control.		
	5.1	Introduction to SCADA. Supervisory Computers. Remote Terminal Units (RTUs). PLC Integration.	
	5.2	Communication Infrastructure. Human Machine Interface (HMI). Alarm Handling. Remote Monitoring and Control.	
	Self-Learning Topics: SCADA Applications in Power Plants, Water Treatment Systems, and Smart Factories.		
6	**CPS and Industrial Internet of Things (IIoT)**		**08**
	After completing this module, students will be able to: • Explain the architecture and working principles of CPS, IIoT, and Digital Twin		

	technologies. • Analyze cloud-based monitoring and intelligent maintenance systems used in smart manufacturing.		
	6.1	Introduction to CPS Architecture. IIoT Architecture. Digital Twins. Cloud Communication.	
	6.2	Data Acquisition Using IIoT. Intelligent Monitoring Systems. Predictive Maintenance Applications.	
	Self-Learning Topics: Digital Twin and IIoT Applications in Smart Manufacturing and Predictive Maintenance.		
	Total		**45**

Suggested List of Experiments/Tasks:

Experiment /Task No.	Title of the Experiment/ Task
1	**Study of Industrial Automation Systems and Material Handling Equipment.** **Learning Objective:** To understand various automation systems and material handling devices used in industries. **Learning Outcome:** Students will be able to identify automation systems and material handling equipment used in manufacturing.
2	**Classification and Coding of Components Using Group Technology.** **Learning Objective:** To study part classification and coding systems used in group technology. **Learning Outcome:** Students will be able to classify components and develop coding schemes for manufacturing applications.
3	**Study and Selection of Industrial Sensors and Transducers.** **Learning Objective:** To understand the working principles and applications of industrial sensors. **Learning Outcome:** Students will be able to select suitable sensors for automation applications.
4	**PLC Architecture and Ladder Logic Programming Assignment.** **Learning Objective:** To understand PLC hardware architecture and basic programming concepts. **Learning Outcome:** Students will be able to develop simple ladder logic programs for automation tasks.
5	**CNC Part Programming for Basic Machining Operations.** **Learning Objective**: To learn CNC programming fundamentals for automated machining. **Learning Outcome**: Students will be able to prepare CNC programs for simple machining operations.
6	**Case Study on Flexible Manufacturing Systems (FMS).** **Learning Objective:** To study the structure and applications of FMS in manufacturing. **Learning Outcome:** Students will be able to analyze FMS configurations and their benefits.
7	**PLM** Software **Study and Product Lifecycle Analysis.** **Learning Objective: To** understand **product lifecycle management concepts and software tools.** **Learning Outcome:** Students will be able to explain PLM phases and applications in industry.
8	**Quality Improvement Study Using Kanban, JIT, and Ishikawa Techniques.** **Learning Objective:** To apply lean and quality improvement techniques in manufacturing systems. **Learning Outcome**: Students will be able to recommend process improvements using

	quality tools.
9	**SCADA System Architecture and HMI Design Study.** **Learning Objective:** To understand SCADA architecture and HMI functionalities. **Learning Outcome:** Students will be able to explain SCADA system components and monitoring functions.
10	**Industrial Communication and PLC-SCADA Integration Assignment.** **Learning Objective:** To study communication networks used in automation systems. **Learning Outcome:** Students will be able to explain PLC-SCADA integration for industrial control.

Text Books:

1. Industrial Automation and Robotics – S. K. Gupta, S. Chand Publications, Latest Edition.
2. Automation, Production Systems and Computer Integrated Manufacturing – Mikell P. Groover, McGraw Hill, 5th Edition.
3. Industrial Instrumentation and Control – S. K. Singh, McGraw Hill Education, Latest Edition.

Reference Books:

1. Programmable Logic Controllers – Frank D. Petruzella, McGraw Hill, 5th Edition.
2. Industrial Automation and Process Control – A. K. Gupta & S. K. Arora, Mercury Learning, Latest Edition.
3. SCADA Systems and Applications – Stuart A. Boyer, ISA Publications, Latest Edition.
4. Computer Integrated Manufacturing – P. Radhakrishnan, S. Subramanyan & V. Raju, New Age International, 3rd Edition.
5. Industry 4.0: The Industrial Internet of Things – Alasdair Gilchrist, Apress, Latest Edition.
6. Product Lifecycle Management – John Stark, Springer, 4th Edition

Assessment Methodology:

Type of Assessment	Assessment Tools
Continuous Assessment (CA) (20 Marks)	Certification: NPTEL (20 Marks) (Approved by instructor) **OR** Any 02 Pedagogies (10 marks each) • MCQ /Class Test • Case study/Assignment • GATE based Assignment • Certification Udemy/Coursera (Approved by instructor) • Open Book Test • Working model / Simulation of a course-based concept.
Mid Semester Examination (MSE) (30 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • For each question, A and B should be based on the same CO. • MSE should be based on 50% syllabus. • Time: 90 minutes (1 hour 30 minutes)
End Semester Examination (ESE) (50 Marks)	Question Paper Pattern is as follows: All Questions are compulsory. • Q1 A or B - 10 marks • Q2 A or B - 10 marks • Q3 A or B - 10 marks • Q4 A or B - 10 marks • Q5 A or B - 10 marks • For each question, A and B should be based on the same CO. • ESE should be based on 30% syllabus of MSE and 70% syllabus after MSE. • Time: 120 minutes (02 hours) • Total Marks: 50
Term Work (25 Marks)	• Active Participation (Lab) = 05 marks • Laboratory Report / Journal = 10 marks • Laboratory Performance = 10 marks Based on the performance & satisfactory completion of minimum 8 experiments.

Course Vertical 4- Ability Enhancement Course (AEC): Total Credits: 02

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ILAEC02	Professional Communication Skills	L	P	T	L	P	T	Total
		-	2	-	-	2	-	2
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	-	-	-	-
		Lab	-	-	-	50	-	-	50

Pre-Requisite Courses:	25FEAEC01 Effective Communication Skills
	Theory of Communication, Communication cycle, effective use of body language and barriers to communication

Course and Module Overview:

This course is designed to develop professional communication competencies required in academic, technical, corporate, and global workplace environments. The course focuses on enhancing verbal, written, interpersonal, digital, and presentation communication skills essential for engineering graduates and professionals. Students will develop the ability to communicate effectively in professional settings through technical writing, presentations, group discussions, workplace interactions, and digital communication platforms.

The course also emphasizes leadership communication, critical thinking, emotional intelligence, corporate etiquette, teamwork, and interview readiness. Practical activities such as mock interviews, presentations, group discussions, report writing, and role play simulations provide experiential learning opportunities to prepare students for placements, internships, entrepreneurship, and professional careers.

The course integrates modern communication practices including AI-assisted communication tools, digital collaboration platforms, professional networking, and global workplace communication standards to ensure industry relevance and employability readiness.

Module Overview

Module 1- Advanced Professional Communication

This module develops advanced professional communication competencies required in workplace and corporate environments. It focuses on persuasive communication, negotiation skills, emotional intelligence, workplace ethics, and cross-cultural communication. Students will learn to communicate strategically, handle professional interactions effectively, and resolve workplace conflicts through appropriate communication practices.

Module 2- Technical and Business Writing

This module emphasizes professional writing skills required for technical and corporate communication. Students will learn technical report writing, proposal drafting, executive summaries, research documentation, professional emails, meeting documentation, and AI-assisted writing practices used in industry and academic environments

Module 3- Corporate Speaking & Group Communication

This module develops professional speaking and interpersonal communication abilities. It focuses on presentations, group discussions, panel discussions, interview communication, storytelling techniques, and corporate meeting simulations. Students will strengthen public speaking confidence, teamwork communication, and leadership interaction skills.

Module 4- Digital Communication & AI Tool

This module introduces modern digital communication platforms and AI-based communication tools used in professional environments. Students will learn professional networking, digital etiquette, prompt engineering basics, AI-assisted content generation, online collaboration, and personal branding strategies for digital workplace communication.

Module 5- Placement and Career Readiness

This module prepares students for internships, placements, and professional careers through resume building, portfolio development, interview preparation, corporate professionalism, and workplace communication practices. Students will gain confidence in handling HR, technical, behavioral, and stress interviews effectively.

Module 6- Leadership, Innovation & Global Workplace Skills

This module focuses on leadership communication, innovation pitching, entrepreneurship communication, design thinking, crisis communication, and multicultural workplace interaction. Students will develop the communication competencies required for leadership roles, global collaboration, and future workplace environments

	After successful completion of the course, the students will be able to:	
Course Outcomes (COs)	CO1	Define the fundamentals of professional, technical, digital, and workplace communication. (Remember)
	CO2	Explain communication models, professional ethics, corporate communication practices, and workplace interaction strategies. (Understand)
	CO3	Apply verbal, written, presentation, and digital communication skills in academic, technical, and professional contexts. (Apply)
	CO4	Analyze workplace communication situations, group discussions, negotiation scenarios, and professional challenges to identify suitable communication strategies. (Analyze)
	CO5	Evaluate leadership communication, ethical communication practices, and cross-cultural workplace interactions in professional environments. (Evaluate)
	CO6	Create technical reports, business documents, presentations, resumes, portfolios, and AI-assisted communication content for industry readiness. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Advanced Professional Communication**	05
		After completing this module, students will be able to: • Define advanced workplace communication concepts and communication models. • Analyze workplace communication scenarios and conflict situations. • Demonstrate emotional intelligence and ethical communication practices. • Communicate effectively in multicultural and global workplace settings.	
	1.1	Fundamentals of Professional Communication: Types of professional communication and principles of effective communication.	
	1.2	Workplace Communication Skills: Formal and informal workplace communication, Internal and external communication, corporate communication structure, Professional interaction techniques.	
	1.3	Persuasive Communication and Influencing Skills: Persuasion techniques, Negotiation communication, Influencing strategies Assertive communication.	
	1.4	Emotional Intelligence, Interpersonal Skills and Professional Etiquettes: Ethical communication practices, Professional behavior and etiquette, corporate responsibility in communication and Confidentiality and professionalism.	
		Self-Learning Topics: Watch corporate communication videos and prepare observation report.	
2		**Technical and Business Writing**	07
		After completing this module, students will be able to: • Draft technical reports, proposals, and executive summaries professionally. • Prepare professional emails, meeting agendas, and minutes. • Apply concise and structured business writing principles.	
	2.1	Technical Report Writing: Structure of technical reports, Formal writing style, Data presentation techniques, Report formatting standards.	
	2.2	Business Correspondence: Professional email writing, Escalation and response mails, and corporate communication drafting.	
	2.3	Technical proposal Writing: Proposal writing structure, Writing executive summaries, Parts a technical proposal documentation standard.	
	2.4	Business Meeting Documentation: Notice and agenda preparation, writing meeting minute, Documentation practices, Official communication records, conducting business meeting and AI tools for professional writing Content refinement techniques, Grammar and style checking tools, Ethical use of AI in documentation.	

	Self-Learning Topics: Create documentation using AI tools.		
3	**Corporate Speaking & Group Communication**		**05**
	After completing this module, students will be able to: • Deliver professional and impactful presentations confidently. • Participate effectively in group discussions, panel discussions, and meetings. • Demonstrate leadership and teamwork communication skills. • Apply storytelling and audience engagement techniques in presentations. • Handle interview communication professionally.		
	3.1	Professional Presentation Skills**:** Presentation structure Visual aids and slide design, Voice modulation and body language, Audience engagement techniques.	
	3.2	Group Discussions**:** GD strategies and participation, Analytical and critical discussion skills, Leadership during discussions Professional interaction techniques.	
	3.3	Team Communication and Collaboration: Team interaction methods, Collaborative communication, Workplace coordination, Communication in projects, Storytelling techniques, Persuasive presentation methods, corporate storytelling and Influencing audience perception.	
	3.4	Interview Communication Mastery: HR interview communication, technical interview interaction, Behavioral interview handling and Mock interview practice.	
	Self-Learning Topics: Record and analyze personal presentation videos.		
4	**Digital Communication & AI Tool**		**05**
	After completing this module, students will be able to: • Use professional digital communication platforms effectively. • Build professional online profiles and digital presence. • Apply AI tools for presentations, reports, and communication tasks. • Demonstrate digital etiquette and cyber professionalism. • Develop personal branding and online reputation management strategies.		
	4.1	Digital Communication Platforms: Professional communication tools, Email and virtual communication, Online collaboration platforms and Digital workplace communication.	
	4.2	LinkedIn and Professional Networking: LinkedIn profile optimization, Professional networking strategies, Building online professional identity and Networking etiquette.	
	4.3	AI Tools for Communication: AI tools for presentations, AI-assisted report writing, Communication automation tools and Productivity enhancement using AI.	
	4.4	Digital Etiquette and Cyber Professionalism: Online professional behavior, Cyber ethics and safety, Responsible digital communication and	

		Professional conduct in virtual environments, Personal branding strategies, Online presence management, and Digital reputation building and Professional portfolio creation.	
	Self-Learning Topics: Build personal online portfolio.		
5	**Placement and Career Readiness**		**05**
	After completing this module, students will be able to: • Prepare ATS-friendly resumes and professional portfolios. • Demonstrate effective communication during HR and technical interviews. • Apply the STAR method while answering interview questions. • Exhibit corporate professionalism and workplace readiness. • Communicate confidently during placement and internship processes.		
	5.1	Resume and Portfolio Development: Resume writing techniques, ATS-friendly resume preparation, cover letters, Portfolio building methods and Career documentation standards.	
	5.2	Placement Communication Skills: Internship communication, Placement interaction strategies, corporate communication readiness and Professional self-introduction.	
	5.3	HR and Technical Interviews: HR interview preparation, technical interview handling, Stress interview techniques, Behavioral interview strategies, Structured interview responses, Situation-based communication and Answer organization techniques.	
	5.4	Corporate Professionalism and Workplace Readiness: Workplace expectations Professional ethics and conduct, Office communication etiquette and Time and task communication, Career planning communication, Workplace adaptability, Professional relationship management, and Industry communication practices.	
	Self-Learning Topics: Watch placement interview sessions and prepare reflection report.		
6	**Leadership, Innovation & Global Workplace Skills**		**03**
	After completing this module, students will be able to: • Demonstrate leadership and innovation communication skills. • Present entrepreneurial and technical ideas effectively. • Apply design thinking and workplace problem-solving communication. • Handle crisis communication situations professionally. • Work effectively in multicultural and global professional environments.		
	6.1	Leadership Communication: Leadership communication styles, Motivational communication, Decision-making communication and Team leadership interaction.	
	6.2	Innovation and Entrepreneurial Communication: Startup pitching techniques, Entrepreneurial communication and Innovation presentations and Business idea communication.	

	6.3	Crisis Communication and Media Handling: Crisis management communication, Media interaction basics, Reputation management and Emergency communication strategies.	
	6.4	Future Workplace Skills and Industry 5.0 Communication: Future communication trends, Human-AI workplace collaboration, Smart workplace communication and Industry 5.0 professional competencies	
	6.5	Smart manufacturing and Industry 4.0.	
	Self-Learning Topics: Study successful startup presentations.		
	Total		**30**

List of Assignments

1. Case studies on ethical communication practices.
2. Draft a technical proposal on a given topic.
3. Presentation on Interpersonal Skills.
4. Short note on AI Tools for communication.
5. Prepare a cover letter with resume for the given position
6. Write a detailed note on industry 5.0 professional competencies.

Suggested List of Activities:

Activity No.	Title of the Activities
1	**Mock GD 1** **Learning Objective:** To develop students' ability to participate actively and effectively in group discussions. **Learning Outcome:** Students will be able to present opinions logically, listen actively to others, and contribute meaningful ideas during group discussions.
2	**Business Meeting** **Learning Objective:** To train students in professional communication and collaboration during formal business meetings. **Learning Outcome:** Students will be able to participate professionally in meetings, communicate ideas clearly, and demonstrate teamwork and meeting etiquette.
3	**Mock GD 2** **Learning Objective:** To enhance students' confidence and communication skills in group discussion settings. **Learning Outcome:** Students will be able to articulate viewpoints confidently, support arguments with relevant points, and engage constructively in discussions.
4	**Presentation on Interpersonal Skills** **Learning Objective:** To develop students' presentation and interpersonal communication skills. **Learning Outcome:** Students will be able to organize and deliver structured presentations while demonstrating effective verbal and non-verbal communication

	skills.
5	**Mock Interviews** **Learning Objective:** To prepare students for professional interviews through practice and self-assessment. **Learning Outcome:** Students will be able to answer interview questions confidently, exhibit professional behavior, and communicate their strengths effectively.
6	**Creation of LinkedIn profile** **Learning Objective:** To guide students in building a professional online presence for career opportunities. **Learning Outcome:** Students will be able to create a professional LinkedIn profile showcasing their qualifications, achievements, skills, and career interests effectively.
7	**Debate on emerging technologies** **Learning Objective:** To encourage critical thinking and effective public speaking through debate activities. **Learning Outcome:** Students will be able to express arguments logically, defend viewpoints confidently, and participate actively in formal debates.
8	**Pitching a startup idea / Pitching idea presentation** **Learning Objective:** To enable students to present innovative business ideas persuasively and professionally. **Learning Outcome:** Students will be able to explain a startup idea clearly, justify its feasibility and value, and deliver an effective pitch presentation.
9	**Final Group Discussion** **Learning Objective:** To assess a students' overall group discussion and communication skills. **Learning Outcome:** Students will be able to participate confidently in discussions, present relevant ideas effectively, and demonstrate collaborative communication skills.
10	**Final presentation on Project** **Learning Objective:** To develop students' ability to present project work in a structured and professional manner. **Learning Outcome:** Students will be able to prepare and deliver organized project presentations with clarity, confidence, and effective audience engagement.

Text Books:

1. Business Communication Today – Bovee & Thill
2. Technical Communication – Meenakshi Raman

Reference Books:

1. Business Communication Today – Bovee & Thill
2. Technical Communication – Meenakshi Raman
3. HBR Guide to Persuasive Presentations
4. Crucial Conversations – Patterson et al.
5. The Quick and Easy Way to Effective Speaking – Dale Carnegie

Assessment Methodology:

Type of Assessment	Assessment Tools
Term Work (50 Marks)	• Active Participation (Lab) = 05 marks • Assignments = 10 marks • Activity = 10 marks • Total = 25 Marks Based on the performance & satisfactory completion of all activities. • Book Report = 05 marks • Presentation + 10 Marks • Final Group Discussion +10 Marks • Total = 25 Marks

Course Vertical 5 - Experiential Learning Courses (ELC): Total Credits: 02+01

Course Code	Course Name	Teaching Scheme (Hrs./ Week)			Credits Assigned			
25ET5ELC01	Research Methodology	L	P	T	L	P	T	Total
		2	-	-	2	-	-	2
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	50	-	-	50
		Lab	-	-	-	-	-	-	-

Pre-Requisite Courses:	25FE1BSE01 Engineering Mathematics 01

Course and Module Overview:

This course introduces engineering students to the principles and practices of scientific research, covering problem identification, literature review, research design, experimental methods, data analysis, technical writing, research ethics, intellectual property rights, and publication practices. The course aims to equip students with the knowledge and skills required to understand research methodologies, formulate research problems, develop appropriate research designs, apply experimental, computational, and analytical methods in engineering investigations, analyze and interpret data using statistical techniques, and effectively communicate research findings through technical writing and presentations. It also provides an understanding of ethical considerations, intellectual property rights, and publication standards, thereby preparing students to undertake research projects, publish technical papers, and pursue innovation in engineering

Module Overview

Module 1- Introduction to Engineering Research Concepts and Types of Research
This module **i**ntroduces the fundamentals of engineering research, including its purpose, significance, and role in technological innovation. It covers the research process, scientific inquiry, and various types of research such as basic, applied, experimental, and computational research. Students will gain an understanding of how research contributes to solving engineering problems and advancing technology.

Module 2- Literature Review and Research Problem Formulation
This module focuses on identifying research problems and conducting effective literature reviews. It introduces techniques for searching, evaluating, and synthesizing scholarly literature to identify research gaps and formulate research objectives, questions, and hypotheses. Students will develop the ability to define meaningful engineering research problems based on existing knowledge and emerging challenges.

Module 3- Research Design and Methodology
This module introduces the principles of research design and methodology used in engineering research. It covers the selection of appropriate research approaches, methods, and procedures for conducting systematic investigations. Students will learn to design research studies, develop experimental plans, select data collection methods, and ensure the reliability and validity of research outcomes.

Module 4- Data Collection and Statistical Analysis

This module focuses on methods of data collection, organization, and analysis in engineering research. It introduces primary and secondary data sources, sampling techniques, and statistical tools used for data interpretation. Students will learn to apply descriptive and inferential statistics to analyze research data, draw meaningful conclusions, and support evidence-based decision-making.

Module 5- Research Ethics, IPR, and Technical Publications

This module introduces the ethical, legal, and professional aspects of engineering research. It covers research integrity, plagiarism, intellectual property rights (IPR), patents, copyrights, and scholarly publishing practices. Students will gain an understanding of ethical research conduct, protection of research outcomes, and the process of publishing technical papers in journals and conferences.

Module 6- Technical Writing and Research Presentation

This module focuses on the effective communication of research findings through technical writing and professional presentations. It covers the preparation of research papers, technical reports, theses, and research proposals, along with citation and referencing practices.

	After successful completion of the course, the students will be able to:	
Course Outcomes (COs)	CO1	Explain the fundamental concepts, types, and processes of research in engineering and technology. (Remember)
	CO2	Identify research problems, formulate objectives and hypotheses, and conduct a comprehensive literature review using scientific databases. (Understand)
	CO3	Design appropriate research methodologies, experiments, and data collection procedures for engineering investigations. (Apply)
	CO4	Apply statistical and analytical techniques to collect, process, analyze, and interpret research data. (Analyze)
	CO5	Demonstrate awareness of research ethics, plagiarism, intellectual property rights (IPR), and publication practices. (Evaluate)
	CO6	Prepare and present research proposals, technical reports, dissertations, and research papers in a professional format. (Create)

Syllabus:

Module No.	Unit No.	Topics	Hours
1		**Introduction to Engineering Research Concepts and Types of Research**	04
		After completing this module, students will be able to: • Understand the fundamentals and scope of engineering research.	
	1.1	Meaning, objectives, and significance of research; Types of research: Basic research, Applied research, Experimental research, Computational research, Action research; Characteristics of good research, Research process and scientific method, Engineering research challenges and opportunities.	
		Self-Learning Topics: Emerging Research Paradigms, Research Impact Assessment, Global Research Trends, AI in Engineering Research, Technology Transfer.	
2		**Literature Review and Research Problem Formulation**	04
		After completing this module, students will be able to: • Formulate research problems and conduct literature reviews.	
	2.1	Identification of research problems, Selection of research topics, Research objectives and questions, Hypothesis formulation, Research gap identification, Sources of technical literature, Literature survey techniques, Citation and referencing methods, Use of digital databases and search engines.	
		Self-Learning Topics: Research Question Development Frameworks, AI-Assisted Literature Reviews, Critical Analysis of Research Papers.	
3		**Research Design and Methodology**	08
		After completing this module, students will be able to: • Design suitable methodologies for engineering research.	
	3.1	Research design concepts, Quantitative and qualitative research methods, Experimental research design, Survey methods, Case study approach, Modeling and simulation-based research, Variables and measurement scales, Reliability and validity.	
		Self-Learning Topics: Bibliometric Analysis, AI-Assisted Research.	
4		**Data Collection and Statistical Analysis**	06
		After completing this module, students will be able to: • Collect and analyze engineering data.	
	4.1	Sources of data, Primary and secondary data, Sampling methods, Questionnaire design, Data coding and classification, Descriptive statistics, Probability distributions, Hypothesis testing, Correlation and regression analysis, Analysis of Variance (ANOVA).	
		Self-Learning Topics: Data Ethics and Privacy, Open Data Repositories, Uncertainty Analysis, and Perform exploratory analysis on an open dataset.	
5		**Research Ethics, IPR, and Technical Publications**	04

	After completing this module, students will be able to: • Understand ethical and legal aspects of research.		
	5.1	Research ethics, Plagiarism and academic integrity, Ethical issues in engineering research, Intellectual Property Rights (IPR), Patents, copyrights, trademarks, Patent search and filing basics, Journal publications and conferences, Peer-review process.	
	Self-Learning Topics: Responsible Conduct of Research, Ethics in Emerging Technologies, Open Science Practices, Predatory Publishing, Research Visibility and Scholarly Identity.		
6	**Technical Writing and Research Presentation**		**04**
	After completing this module, students will be able to: • Communicate research findings effectively.		
	6.1	Scientific Writing, Research proposal writing and Funding Agencies, Thesis and dissertation preparation, writing journal papers, Preparation of tables, figures, and references IEEE and APA, MLA, Chicago Style and Harvard, Vancouver referencing styles, Use of Reference Management Tools (Zotero, Mendeley, EndNote), Responding to Reviewers' Comments and Manuscript Revision, Research Communication through Blogs and social media.	
	Self-Learning Topics: Graphical Abstracts and Infographics, Digital Tools for Academic Writing, Peer Review and Manuscript Revision.		
	Total		**30**

Reference Books:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, John W. Creswell, J. David Creswell 6th Edition, SAGE Publications, 2023.
2. Research Methodology: Methods and Techniques, C. R. Kothari, Gaurav Garg, 5th Edition, New Age International Publishers, 2024
3. Research Methodology for Engineers, by R. Ganesan, MJP Publishers, 2024

Useful Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ge66
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge79
3. https://ocw.mit.edu/courses/esd-932-engineering-ethics-spring-2006/
4. https://ocw.mit.edu/courses/15-348-doctoral-seminar-in-research-methods-ii-spring-2004/

Assessment Methodology:

Type of Assessment	Assessment Tools
Term Work (50 Marks)	Any two pedagogy (10 marks each) for an individual student. • Literature Review Assignment • Statistical Analysis Using Software • Patent Search Activity The following technical Group activity/Tasks of 10 Marks each to be completed during the semester. • Technical Paper Review and Presentation • Research Problem Identification Exercise • Research Proposal Preparation So Total 50 Marks are assigned as a part of term work in the course.

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25ET5CEP03	Community Engagement Project 3	L	P	T	L	P	T	Total
		-	2	-	-	1	-	1
		Examination Scheme						
			CA	MSE	ESE	TW	OR	PR	Total
		Theory	-	-	-	-	-	-	-
		Lab	-	-	-	25	-	25	50

Pre-Requisites Courses	25ET3CEP01 Community Engagement Project 1
	25ET4CEP02 Community Engagement Project 2

Course Overview

Community Engagement Project 3 provides students with an opportunity to develop, validate, and assess engineering solutions addressing community and societal needs. The course emphasizes the application of engineering knowledge, stakeholder engagement, literature exploration, performance evaluation, and systematic problem-solving to enhance the effectiveness and sustainability of proposed solutions. Students are encouraged to adopt innovative approaches, ethical practices, and sustainable engineering principles while developing technical, professional, and interpersonal competencies. The course also promotes the attainment of relevant Knowledge and Attitude Profiles (KAPs) and alignment with Sustainable Development Goals (SDGs) through community-oriented engineering activities.

Learning Objectives

1. To identify and analyze community needs and societal challenges requiring engineering interventions
2. To investigate existing technologies, methodologies, and best practices relevant to the selected problem domain.
3. To apply appropriate engineering tools and techniques for the development, refinement, and validation of community-oriented solutions.
4. To evaluate the performance, effectiveness, and sustainability of engineering solutions through testing, analysis, and stakeholder feedback.
5. To strengthen innovation, teamwork, communication skills, ethical responsibility, lifelong learning, and the attainment of relevant Knowledge and Attitude Profiles (KAPs) while contributing to Sustainable Development Goals (SDGs)**.**

	After successful completion of the course, the students will be able to:	
	CO1	Goals (SDGs), and relevant Knowledge and Attitude Profiles (KAPs) associated with the selected project. (Remember – Factual Knowledge)
	CO2	Explain the social, environmental, technological, economic, and ethical factors influencing the development and implementation of community-oriented engineering solutions. (Understand – Conceptual Knowledge).
	CO3	Apply appropriate engineering tools, techniques, methodologies, and technologies to develop and improve solutions addressing identified community needs. (Apply – Procedural Knowledge)

	CO4	Analyse system performance, stakeholder feedback, implementation challenges, and operational constraints to determine the effectiveness of the proposed solution. (Analyse – Conceptual and Procedural Knowledge)
	CO5	Evaluate the functionality, sustainability, reliability, inclusiveness, and societal impact of the developed solution using appropriate technical and community-benefit criteria. (Evaluate – Metacognitive Knowledge)
	CO6	Design and validate an innovative, sustainable, and socially relevant engineering solution that addresses community needs while demonstrating responsible professional attitudes and relevant KAP attainment. (Create – Metacognitive Knowledge)

Syllabus:

Module No.	Unit No.	Topics	Hours
1	**Project Identification and Community Need Analysis**		**05**
	1.1	Identification of community needs, societal challenges, and opportunities for engineering interventions.	
	1.2	Stakeholder identification and requirement gathering through surveys, interviews, and field observations.	
	1.3	Mapping project objectives with Sustainable Development Goals (SDGs).	
	1.4	Knowledge and Attitude Profiles (KAPs): Professional ethics, leadership, teamwork, sustainability, and lifelong learning in engineering practice.	
2	**Literature Review and Problem Analysis**		**05**
	2.1	Literature survey using journals, conference papers, patents, standards, and technical reports.	
	2.2	Study of existing technologies, methodologies, and related solutions.	
	2.3	Comparative analysis and identification of limitations of existing approaches.	
	2.4	Refinement of problem statement, objectives, scope, and performance requirements.	
3	**System Design and Solution Development**		**05**
	3.1	Development of system architecture, block diagrams, workflow, and methodology.	
	3.2	Selection of hardware, software, communication, networking, IoT, embedded systems, or signal processing techniques as applicable.	

	3.3	Design, simulation, modelling, or prototype enhancement activities.	
	3.4	Planning of implementation strategy, resources, and project milestones.	
4	**Implementation, Results and Validation**		**05**
	4.1	Development, integration, and testing of project components.	
	4.2	Functional verification and troubleshooting.	
	4.3	Performance measurement using appropriate technical metrics.	
	4.4	Validation of outcomes through stakeholder feedback, experiments, simulations, or field observations.	
5	**Performance Evaluation and Sustainability Assessment**		**05**
	5.1	Analysis of project performance and achievement of objectives.	
	5.2	Evaluation of reliability, usability, accessibility, and effectiveness.	
	5.3	Assessment of sustainability, societal relevance, and community impact.	
	5.4	Identification of future improvements and scalability opportunities.	
6	**Documentation, Presentation and Reflection**		**05**
	6.1	Preparation of technical reports, project portfolios, and supporting documentation.	
	6.2	Documentation of challenges, observations, and lessons learned, and best practices.	
	6.3	Project presentation, demonstration, and technical communication.	
	6.4	Reflection on innovation, ethical responsibility, teamwork, leadership, KAP attainment, and societal contribution.	
TOTAL			**30**

Suggested Software Tools

1. **Microsoft Excel / Google Sheets** – Data collection, analysis, performance evaluation, visualization, and result interpretation.
2. **Google Forms / Microsoft Forms** – Requirement gathering, stakeholder feedback collection, surveys, and project evaluation.
3. **Python (with relevant libraries)** – Data analysis, simulation, automation, machine learning, visualization, and performance assessment.
4. **MATLAB / Simulink** – System modelling, simulation, signal processing, communication system analysis, and performance evaluation.
5. **Arduino IDE / PlatformIO** – Development, programming, and testing of microcontroller-based and IoT-enabled systems.
6. **Keil µVision / MPLAB X IDE** – Embedded system design, simulation, debugging, and

microcontroller programming.

7. **Proteus Design Suite / Multisim / LTspice** – Circuit design, simulation, testing, and validation of analog and digital systems.
8. **Cisco Packet Tracer / GNS3** – Network design, simulation, protocol analysis, and communication system studies.
9. **ThingSpeak / Blynk / Node-RED** – IoT application development, data monitoring, visualization, and cloud-based system integration.
10. **Canva / Microsoft PowerPoint / Google Slides** – Technical presentations, project demonstrations, documentation, and dissemination of project outcomes.
11. **Trello / Notion / Microsoft Planner** – Project planning, activity tracking, milestone management, and team collaboration.
12. **GitHub / GitLab** – Version control, project repository management, collaborative development, and documentation.

Note:

The listed tools are indicative and support project planning, literature review, system design, simulation, implementation, testing, validation, performance analysis, technical documentation, and project management activities. Equivalent open-source or institutionally available software tools may also be used as per project requirements and the selected project domain.

Suggested Online References

1. Smart India Hackathon (SIH) – Innovation, problem-solving and engineering project ideas. https://www.sih.gov.in
2. All India Council for Technical Education (AICTE) – Activity Points, project-based learning, and experiential learning guidelines. https://www.aicte-india.org
3. AICTE Internship Policy and Activity Points Programme – Student engagement and project-based learning activities. https://internship.aicte-india.org
4. IEEE Xplore Digital Library – Research papers, conference proceedings, and technical literature in engineering and technology. https://ieeexplore.ieee.org
5. Google Scholar – Scholarly articles, research papers, patents, and citations. https://scholar.google.com
6. SpringerLink – Engineering, technology, and interdisciplinary research publications. https://link.springer.com

7. ScienceDirect – Scientific and engineering journals, articles, and research resources. https://www.sciencedirect.com
8. IEEE Humanitarian Technologies Board (HTB) / IEEE SIGHT – Community-oriented engineering projects and humanitarian technology solutions. https://sight.ieee.org
9. United Nations Sustainable Development Goals (SDGs) Portal – Official information on SDGs and sustainability targets. https://sdgs.un.org/goals
10. United Nations Development Programme (UNDP) – Sustainable development initiatives and implementation resources. https://www.undp.org/sustainable-development-goals
11. Engineering for Change (E4C) – Engineering solutions, project examples, and technology-for-society resources. https://www.engineeringforchange.org
12. MIT D-Lab – Community-driven innovation and sustainable engineering solutions. https://d-lab.mit.edu
13. GitHub – Open-source software repositories, project documentation, and collaborative development resources. https://github.com
14. NPTEL – Online courses, project guidance, and engineering learning resources. https://nptel.ac.in
15. National Digital Library of India (NDLI) – Academic resources, books, journals, theses, and project references. https://ndl.iitkgp.ac.in

Note:

The listed resources support literature survey, project planning, system design, implementation, validation, technical documentation, sustainable engineering practices, community-oriented innovation, and the attainment of relevant SDGs and KAPs. Equivalent open-source, institutional, or government-supported resources may also be utilized as per project requirements.

Course Guidelines

1. **Student Group Formation:** Students shall form groups consisting of exactly four (4) members in accordance with AICTE guidelines for project-based and experiential learning. Groups with fewer or more than four students shall not be permitted.
2. **Alignment with Sustainable Development Goals (SDGs) and Knowledge & Attitude Profiles (KAPs):** Each group shall identify at least one relevant United Nations Sustainable Development Goal (SDG) and demonstrate the development of applicable Knowledge and Attitude Profiles (KAPs) through the selected project activity. The alignment shall be clearly justified in the project report.
3. **Problem Identification and Stakeholder Interaction:** Students shall identify a community need, societal challenge, or engineering problem through stakeholder interaction, field observations, surveys, interviews, or other suitable methods to establish project objectives and requirements.
4. **External Stakeholder Participation:** Each group shall engage with at least one external stakeholder, community representative, industry expert, NGO, local body, institution, or domain expert and provide suitable documentary evidence of interaction, consultation, or feedback as part of the project documentation.
5. **Project Selection and Development:** Students may undertake a new project or continue an existing project with appropriate enhancements, validation, performance evaluation, and technical improvements based on stakeholder requirements and engineering analysis.
6. **Project Planning:** Each group shall prepare a structured project plan including objectives, scope, methodology, implementation strategy, resource requirements, milestones, risk factors, expected outcomes, and timelines. The plan shall be reviewed and approved by the faculty mentor.
7. **Design, Development and Validation:** The project may involve system design, simulation, modelling, prototype development, software development, hardware implementation, networking solutions, IoT applications, embedded systems, automation, signal processing, AI/ML applications, or other engineering interventions relevant to the selected problem domain.
8. **Project Monitoring and Documentation:** Students shall maintain a project logbook or progress record documenting weekly activities, design decisions, stakeholder interactions, observations, challenges encountered, corrective actions taken, testing results, and learning outcomes. Faculty mentors shall periodically review the records.
9. **Performance Evaluation and Sustainability Assessment:** Emphasis shall be given to evaluating technical performance, functionality, reliability, usability, stakeholder satisfaction, sustainability, scalability, and societal relevance using appropriate assessment methods and performance indicators.
10. **Project Report Preparation:** Students shall submit a comprehensive report covering problem identification, literature review, methodology, system design, implementation, testing, validation, performance analysis, stakeholder feedback, sustainability assessment, KAP attainment, and alignment with identified SDGs.
11. **Assessment through Demonstration and Presentation:** Each group shall deliver periodic progress presentations and a final presentation demonstrating project outcomes, validation results, technical contributions, stakeholder engagement activities, and recommendations

for future enhancements.

12. **Student-Centric and Outcome-Based Learning:** The project shall be student-driven and promote innovation, critical thinking, teamwork, communication skills, ethical responsibility, leadership, lifelong learning, attainment of relevant KAPs, and Outcome-Based Education (OBE) principles in alignment with NEP 2020.

Assessment Methodology:

Assessment Tools	Marks Distribution
Term Work (25 Marks)	• Project Planning, Progress, Participation and Team Involvement – 5 Marks • Project Report, Design Documentation, Logbook / Progress Record and Technical Documentation – 10 Marks • Progress Presentations (minimum two), Demonstration, Validation Results and Performance Evaluation– 10 Marks
Practical & Oral (25 Marks)	Oral examination shall be based on the problem identification, stakeholder requirements, literature review, methodology, system design, implementation, testing, validation, performance evaluation, sustainability assessment, project documentation, and alignment with identified Sustainable Development Goals (SDGs) and Knowledge and Attitude Profiles (KAPs). Emphasis shall be placed on understanding of engineering concepts, design decisions, technical contributions, stakeholder feedback, project outcomes, and future enhancement opportunities. **Note:** • Assessment shall be based on documented evidence of problem identification, stakeholder interaction, project planning, design activities, implementation, testing, validation, technical documentation, and attainment of project objectives. • The project logbook/progress record shall include weekly activities, design decisions, implementation progress, testing results, observations, challenges encountered, corrective actions, and learning outcomes. • The assessment shall emphasize innovation, technical competency, problem-solving ability, critical thinking, teamwork, communication skills, ethical responsibility, leadership, lifelong learning, attainment of relevant KAPs, and alignment with identified SDGs. • Demonstration of a working model, simulation, prototype, software application, analytical study, or validated engineering solution shall form an important component of the assessment process.

Course Vertical: Open Elective Course (OE): 02 Credits

Course Code	Course Name	Teaching Scheme (Hrs. / Week)			Credits Assigned			
25IL5OEXX	Open Elective Course # (# Refer to the list of Courses)	L	P	T	L	P	T	Total
		2	-	-	2	-	-	2
		Examination Scheme						
			CA	ESE	TW	OR	PR	Total
		Theory	20	30	-	-	-	50

List Of Open Electives (OE) Courses # (02 Credits)

Students are required to **enroll in any one of the NPTEL Open Elective courses from the list of approved courses circulated by the Institute**. Enrolment in courses outside this approved list will not be considered for the Open Elective requirement.

Serial No.	Course Code	Name of Open Elective Courses (OE)
01	25IL5OE01	Energy Economics and Policy
02	25IL5OE02	Economic Environment and Business Strategy
03	25IL5OE03	Ethics in Engineering Practice
04	25IL5OE04	Intellectual Property, Rights and Competition Law
05	25IL5OE05	Principle of Human Resource Management
06	25IL5OE07	Patent Search for Engineers and Lawyers
07	25IL5OE08	Developing Soft Skills and Personality
08	25IL5OE09	Mastering Speaking and Presentation Skills
09	25IL5OE10	Soft Skill Development
10	25IL5OE11	Any other course with the approval of Principal

* For Open Elective Courses, online NPTEL courses approved by Institute

Assessment Methodology:

The assessment for the Open Elective course shall be carried out as follows:

1. **Continuous Assessment (CA)**

- Students shall complete and submit all the weekly NPTEL assignments as per the schedule prescribed by NPTEL.
- The marks obtained in the NPTEL assignments shall be considered for the **Continuous Assessment (CA)** component.

- The assignment marks shall be **scaled to 20 marks** for the purpose of awarding the CA marks.

2. End Semester Examination (ESE)

- Students shall register for and appear in the **NPTEL certification examination** for the Open Elective course in which they have enrolled.
- The marks obtained in the NPTEL certification examination shall be treated as the **End Semester Examination (ESE)** marks for the course.

3. Grade Incentive

- Students who **successfully qualify in the NPTEL certification examination** shall be awarded **one grade higher** than the grade earned based on their overall performance in the course, subject to the Institute's grading regulations.

Total Marks Obtained (%)	DBIT Grade	Incentive Grade for NPTEL Certification	Performance
>=90	O	O	Outstanding
>=80 and <90	A+	O	Excellent
>=70 and <80	A	A+	Very Good
>=60 and <70	B+	A	Good
>=55 and <60	B	B+	Fair
>=50 and <55	C	B	Average
>=40 and <50	D	C	Pass
<40	F	No incentive grade	Fail

4. Students Not Appearing for the NPTEL Examination

- Students who **do not appear** for the NPTEL certification examination shall be required to appear for the **college-conducted End Semester Examination** for the same Open Elective course.
- In such cases, the student **shall not be eligible for the one-grade incentive**, and the final grade shall be awarded based on the marks obtained in the college End Semester Examination together with the Continuous Assessment marks.