Lokmanya Tilak Jankalyan Shikshan Santha's

Lokmanya Tilak College of Engineering

Sector 4, Vikas Nagar, Koparkhairane, Navi Mumbai 400709

An Autonomous Institute Affiliated to University of Mumbai

Department of Computer Science and Engineering

(IoT & Cyber Security Including Blockchain Technology)

CURRICULUM STRUCTURE

For

THIRD YEAR ENGINEERING

(BASED ON NEP 2020)

w.e.f. A.Y. 2026-27

Approved by Board of Studies on 02/05/2026

Approved by Academic Council on 22 /05/2026

Department of Computer Science and Engineering (IoT & Cyber Security Including Blockchain Technology)

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w.e.f. A.Y. 2026-27

Preface

Lokmanya Tilak College of Engineering (LTCE) is founded by a Nagpur-based trust known as Lokmanya Tilak Jankalyan Shikshan Sanstha (LTJSS). The Sanstha was established in 1983, by Honourable Dr. Satish Chaturvedi. At present, there are 28 educational institutes run by the Sanstha in Nagpur. The Sanstha derives its philosophy from the magnanimous mathematician, educationist, social reformer Lokmanya Bal Gangadhar Tilak, who dedicated his life for the cause of Swaraj. Lokmanya Tilak College of Engineering was established in 1994, approved by the All-India Council for Technical Education, New Delhi, recognised by the Govt. of Maharashtra, accredited by NAAC with 'A' grade and is affiliated to the University of Mumbai. Within the span of 30 years of its inception, LTCE has grown leaps and bounds in terms of popular courses being offered at U.G., P.G. and Ph.D. level. Four of its branches viz., Computer, Mechanical, Electrical and Electronics and Telecommunications Engg. have been accredited by NBA. The Institute runs the Under-graduate Programmes in Mechanical Engineering, Computer Engineering, Electronics & Telecommunication Engineering, Electrical Engineering, Computer Science & Engineering (Data Science), Computer Science & Engineering (Artificial Intelligence & Machine Learning) and Computer Science & Engineering (IoT & Cyber Security Including Blockchain Technology). Institute also offers Doctoral Programmes in Mechanical Engineering and Computer Engineering. LTCE stands steadfast in its mission of continuing efforts for the betterment of its students and society.

The National Education Policy 2020, recently implemented by the Government of India, envisions providing quality education to all young people, with the primary goal of nurturing well-rounded, thoughtful, and creative individuals. NEP 2020 also emphasizes the importance of developing character, ethical values, constitutional principles, intellectual curiosity, scientific temper, creativity, and other related virtues. The Government of Maharashtra has instructed autonomous colleges to update their curriculum and begin implementing the National Education Policy (NEP) 2020. We are fully committed to ensuring the effective and meaningful adoption of NEP 2020 in its true essence. At "Lokmanya Tilak College of Engineering", the holistic development of learners has always been our top priority and central focus. LTCE embraced the NEP philosophy as early as 2022 wherein we have introduced the concept of Honors and Minors programs on emerging fields as per the guidelines of University of Mumbai and in 2024, we proudly graduated our first batch under this holistic curriculum. The autonomous curriculum for 2024-28 is structured in line with the recommendations of NEP 2020, AICTE, and UGC. It now includes courses in emerging technologies and multidisciplinary areas to ensure relevance to industry and practical applications. Greater focus has been placed on experiential learning to move away from rote memorization.

Sd/-	Sd/-	Sd/-
Dr. Shilpa M. Wakode	**Dr. Sheeba P. S.**	**Dr. Subhash K. Shinde**
BoS Chairman, CSE (IoT & CSBT)	**Dean, Academics & Research**	**Principal**

Illustrative Semester wise Credit distribution structure for Four Year UG Engineering Program – One Major, One Multidisciplinary Minor as per Maharashtra State Govt. Resolution:

Courses		Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
Basic Science Course	BSC/ESC	6-8	8-10							14-18
Engineering Science Course		8-10	4-6							12-16
Programme Core Course (PCC)	Program Courses		2	8-10	8-10	10-12	8-10	4-6	4-6	44-56
Programme Elective Course (PEC)						4	8	2	6	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses			2	2	4	2	2	2	14
Open Elective (OE) Other than a particular program				4	2	2				8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2		2		2			8
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	2			2					4
Entrepreneurship/Economics/ Management Courses				2	2					4
Indian Knowledge System (IKS)			2							2
Value Education Course (VEC)				2	2					4
Research Methodology	Experiential Learning Courses								4	4
Comm. Engg. Project (CEP)/Field Project (FP)				2						2
Project									4	4
Internship/ OJT								12		12
Co-curricular Courses (CC)	Liberal Learning Courses	2	2							4
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hr. Practical (P) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit

Credit Requirements for Award of Degree:

a) A total of 167 credits are required for a student to be eligible for the award of an **Undergraduate Degree in Engineering**, including a Multi-Disciplinary Minor, in accordance with the Government of Maharashtra GR dated 04/06/2024.

b) A student shall be eligible for the award of an **Undergraduate Degree** with **Honours/Minor**

in Emerging Areas upon earning an additional **18 credits**.

Multiple Exits:

Students will have the flexibility to enter a programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

Distribution of Credits:

Level	Exit After Semester	Minimum Credits Required	LTCE Credits	Qualification Title	Additional Credit requirements
4.5	II (First Year)	40	44	One Year UG Certificate in relevant discipline	8 credits through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
5.0	IV (Second Year)	80	86	Two Years UG Diploma in relevant discipline	**8 credits** through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
5.5	VI (Third Year)	120	127	Three Years B. Voc. in the relevant Discipline	**8 credits** through Skill-based vocational courses (4 Credits) and Internship/ Apprenticeship/ Project (4 Credits).
6.0	VIII (Fourth Year)	160	167	B.Tech. in major discipline with multidisciplinary minor	-----
6.0	VIII (Fourth Year)	160+18= 178	167+18= 185	**B.Tech**. in major discipline with double minor (Multidisciplinary and Emerging minor)	--------

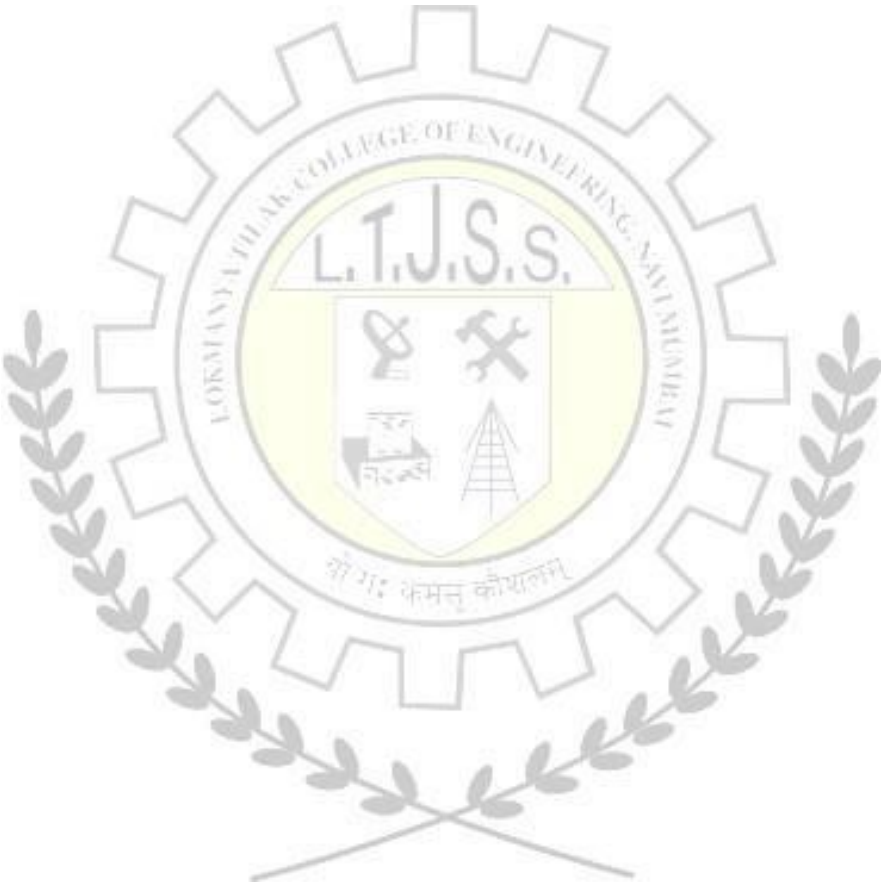
Type of Course	**Course Code**	**No. of Credits as per Maharashtra Govt.**	**No. of credits as per LTCE**
Basic Science Course	BSC	14-18	**16**
Engineering Science Course	ESC	12-16	**14**
Programme Core Course	PCC	44-56	**49**
Programme Elective Course	PEC	20	**19**
Multidisciplinary Minor	MDM	14	**14**
Open Elective (OE) Other	OE	8	**08**

than a particular program			
Vocational and Skill Enhancement Course	VSEC	8	**10**
Ability Enhancement Course (AEC -01, AEC-02)	AEC	4	**03**
Entrepreneurship/Economics/ Management Courses	EEMC	4	**04**
Indian Knowledge System (IKS)	IKS	2	**02**
Value Education Course (VEC)	VEC	4	**04**
Research Methodology	ELC	4	**03**
Comm. Engg. Project (CEP)/Field Project (FP)	ELC	2	**02**
Project	ELC	4	**04**
Internship/ OJT	ELC	12	**12**
Co-curricular Courses (CC)	CC	4	**03**
Total Credits (Major)		**160-176**	**167**
Total Credits (Major+ Honors/Minors)		**178-194**	**167+18=185**

Abbreviations:

AEC	Ability Enhancement Course
AEL	Ability Enhancement Laboratory
BSC	Basic Science Course
BSL	Basic Science Laboratory
CEP	Common Engineering Project
CC	Co-curricular courses
CIE	Continuous Internal Evaluation
ESC	Engineering Science Course
ESE	End Semester Exam
ESL	Engineering Science Laboratory
IKS	Indian Knowledge System
L	Lecture
MDM	Multidisciplinary Minor

MSE	Mid Semester Exam
OE	Open Elective
P	Practical
PCC	Programme Core Course
PCL	Programme Core Laboratory
PEC	Programme Elective Course
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course



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Department of Computer Science & Engineering (IoT & Cyber Security Including Blockchain Technology)

Third Year Engineering Scheme: Semester V (w.e.f. AY 2026-27)

Course Code	Course Name	Teaching Scheme		Credit Assigned		Total Credits	Examination Scheme					
							Internal Assessment		End Semester Exam		Oral &/ Practical	Total
		L	P	L	P		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)	Marks	Duration (Hrs)		
ICPCC501	Computer Network	3	-	3	-	3	20	20	60	2	-	100
ICPCC502	IoT Architecture and Protocols	3	-	3	-	3	20	20	60	2	-	100
ICPCC503	Machine Learning	3	-	3	-	3	20	20	60	2	-	100
ICPEC501x	Program Elective Course	3	-	3	-	3	20	20	60	2	-	100
XXMDM501	Multidisciplinary Minor Course 2	3	-	3	-	3	20	20	60	2	-	100
ICVSEC501	CyberOps Lab	-	2*+2	-	2	2	-	50	-	-	25	75
ICPCL501	Computer Network and Machine Learning Lab	-	2	-	1	1	-	25	-	-	25	50
ICPCL502	IoT Architecture and Protocols Lab	-	2	-	1	1	-	25	-	-	25	50
ICPEL501x	Program Elective Lab	-	2	-	1	1	-	25	-	-	25	50
XXMDML501	Multidisciplinary Minor Lab 2	-	2	-	1	1	-	25	-	-	-	25
Total		**15**	**12**	**15**	**6**	**21**	**100**	**250**	**300**	**10**	**100**	**750**

* e - learning course

ICPEC501x Program Elective Course	**ICPEC5011** Web X	**ICPEC5012** Computational Theory and Compiler Design	**ICPEC5013** Data Analytics and Visualization
ICPEL501x Program Elective Lab	**ICPEL5011** Web X Lab	**ICPEL5012** Computational Theory and Compiler Design Lab	**ICPEL5013** Data Analytics and Visualization Lab

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Third Year Engineering Scheme: Semester VI (w.e.f. AY 2026-27)

Course Code	Course Name	Teaching Scheme		Credit Assigned		Total Credits	Examination Scheme					
							Internal Assessment		End Semester Exam		Oral &/ Practical	Total
		L	P	L	P		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)	Marks	Duration (Hrs)		
ICPCC601	Blockchain Technology	3	-	3	-	3	20	20	60	2	-	100
ICPCC602	Cryptography and Network Security	3	-	3	-	3	20	20	60	2	-	100
ICPEC601x	Program Elective Course 1	3	-	3	-	3	20	20	60	2	-	100
ICPEC602x	Program Elective Course 2	3	-	3	-	3	20	20	60	2	-	100
XXMDM601	Multidisciplinary Minor Course 3	3	-	3	-	3	20	20	60	2	-	100
ICPCL601	Blockchain Technology Lab	-	2	-	1	1	-	25	-	-	25	50
ICPCL602	Cryptography and Network Security Lab	-	2	-	1	1	-	25	-	-	25	50
ICPEL601x	Program Elective Lab	-	2	-	1	1	-	25	-	-	-	25
XXMDML601	Multidisciplinary Minor Lab 3	-	2	-	1	1	-	25	-	-	-	25
ICCEP601	Mini Project II	-	2	-	1	1	-	25	-	-	25	50
Total		**15**	**10**	**15**	**5**	**20**	**100**	**225**	**300**	**10**	**75**	**700**

ICPEC601x Program Elective Course 1	**ICPEC6011** AI with Robotics	**ICPEC6012** Application Security and Secure Coding Principles	**ICPEC6013** Software Engineering
ICPEL601x Program Elective Lab	**ICPEL6011** AI with Robotics Lab	**ICPEL6012** Application Security and Secure Coding Principles Lab	**ICPEL6013** Software Engineering Lab
ICPEC602x Program Elective Course 2	**ICPEC6021** IoT for Smart Systems	**ICPEC6022** Ethical Hacking and Digital Forensic	**ICPEC6023** Augmented and Virtual Reality

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Multidisciplinary Minor (MDM) (14 Credits)

Semester	Computer Engineering (CE)	Electronics & Telecommunication Engineering (ET)	Artificial Intelligence & Robotics (AR)	Internet of Things (IT)	Mechanical Engineering (ME)	Electrical Engineering (EE)
IV	**CEMDM401:** Data Structure and Algorithms	**ETMDM401:** Microprocessor and Microcontroller	**ARMDM401:** Artificial Intelligence	**ITMDM401:** Internet of Things and Applications	**MEMDM401:** Basics of Mechanical Engineering	**EEMDM401:** Elements of Electrical System
	CEMDML401: Data Structure and Algorithms Lab	**ETMDML401:** Microprocessor and Microcontroller Lab	**ARMDML401:** AI Lab	**ITMDML401:** Internet of Things Lab	**MEMDML401:** Mechanical Engineering Lab	**EEMDML401:** Elements of Electrical System Lab
V	**CEMDM501:** Database Management System	**ETMDM501:** Digital Communication & Sensor Technology	**ARMDM501:** Mechatronics	**ITMDM501:** Sensors, Actuators and Transducers	**MEMDM501:** Conventional & Renewable Energy Sources	**EEMDM501:** Special Machines and Smart grid
	CEMDML501: Database Management System Lab	**ETMDML501:** Digital Communication & Sensor Technology Lab	**ARMDML501:** Mechatronics Lab	**ITMDML501:** Sensors, Actuators and Transducers Lab	**MEMDML501:** Renewable Energy Sources Lab	**EEMDML501:** Special Machines and Smart grid Lab
VI	**CEMDM601:** Big Data Computing	**ETMDM601:** Digital Image Processing	**ARMDM601:** Robotics	**ITMDM601:** Microcontrollers and Application	**MEMDM601:** Automobile System	**EEMDM601:** Electric Vehicle Technology
	CEMDML601: Big Data Computing Lab	**ETMDML601:** Digital Image Processing Lab	**ARMDML601:** Robotics Lab	**ITMDML601:** Microcontrollers and Application Lab	**MEMDML601:** Automobile System Lab	**EEMDML601:** Electric Vehicle Technology Lab
VII	**CEMDML701:** Web Design Lab	**ETMDML701:** Mobile Computing Lab	**ARMDML701:** Predictive Maintenance Lab	**ITMDML701:** PLC and SCADA Lab	**MEMDML701:** 3D Printing Lab	**EEMDML701:** Design Management Auditing of Electrical System Lab

Open Elective Courses (OE) (8 Credits)

Semester	Course Code	Course Name
III	OE3011	Biology for Engineers
	OE3012	Indian Constitution and Governance
	OE3013	Human Psychology
	OE3014	Disaster Management and Mitigation
IV	OE4011	Human Resource Management
	OE4012	Corporate and Cyber Laws
	OE4013	Stock Market and Personal Finance
	OE4014	Nutrition Literacy and Health
VIII	OE8011	Intellectual Property Rights (IPR) and Patents
	OE8012	Risk Management
	OE8013	Economics for Engineers
	OE8014	Innovation and Startups

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Third Year Engineering Curriculum: Semester V

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPCC501	Computer Network	20	20	60	1	2	100	

Prerequisite: Concepts of Operating systems	
Course Objectives: The course aims to	
1	Understand the fundamentals of computer networks, their types, architectures, topologies, and communication models.
2	Explain the design and operational mechanisms of the Data Link and Network Layers, including error control, media access, addressing, routing, and data delivery protocols.
3	Describe the functions of the Transport and Application Layers, focusing on connection management, flow and congestion control, and the role of common application protocols in communication.
4	Explore emerging networking technologies and their impact on modern communication systems.
Course Outcomes: Learners will be able to	
1	Explain the fundamental concepts of computer networks, including architectures, topologies, transmission media, and network devices.
2	Demonstrate an understanding of Data Link Layer design principles by implementing error detection, correction, and flow control mechanisms.
3	Apply IPv4 and IPv6 addressing schemes, subnetting techniques, and routing algorithms to achieve efficient packet delivery across networks.
4	Describe the functionalities of transport layer protocols and develop basic socket programs to facilitate process-to-process communication.
5	Analyse the structure, functions, and operations of key application layer protocols such as HTTP, DNS, FTP, and SMTP.
6	Evaluate advanced networking technologies, including VPN, SDN, NFV, and Data Center Networks, and discuss their applications in modern communication systems.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction To Computer Network** Definition, Types of Networks: Local area networks (LAN), Metropolitan area networks (MAN), Wide area networks (WAN), Wireless networks, Networks Software and hardware components, Protocol, Design issues for the layers. Network Models: The OSI Reference Model, TCP/IP Model, Network Topologies, Types of Transmission Medium. Network Architectures: Client-Server, Peer to Peer, hybrid. Network Devices: Bridge, Switch, Router, Gateway, Access Point. **Self-Learning Topic:** Study of Campus wide networking	06	CO1
02	**Data Link Layer**	09	CO2

	Introduction, functions. Design Issues: Services to Network Layer, Framing. ARQ strategies: Error Detection and correction, Parity Bits, Checksum, Hamming Codes and CRC. Flow Control Protocols: Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity: PPP and HDLC. MAC Sub layer: Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, Introduction to IEEE standards (IEEE 802.3, IEEE 802.11).		
03	**Network Layer** Introduction: Functions of Network layer. Switching Techniques: Circuit switching, Message Switching, Packet Switching. IP Protocol: Classes of IP (Network addressing), IPv4, IPv6, Network Address Translation, Sub-netting, CIDR. Network layer Protocols: ARP, RARP, ICMP, IGMP. Network Routing and Algorithms: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing. Routing Protocols: RIP, OSPF, BGP **Self- learning Topic:** Count-to-Infinity Problem, AODV AND DSR routing protocol.	**09**	**CO3**
04	**Transport Layer** Process to Process Delivery, Services, Socket Programming. Elements of Transport Layer Protocols: Addressing, Connection establishment, Connection release, TCP timers and TCP state transition diagram, Flow control and buffering, Multiplexing, Congestion Control: slow start protocol. Transport Layer Protocols: TCP and UDP, Quality of Service (QoS)	**07**	**CO4**
05	**Application Layer** Introduction, Web and HTTP, Web Caching, DNS, Email: SMTP, POP3, Webmail, FTP, TELNET, DHCP, SNMP. **Self-Learning Topic:** GOOGLE DNS	**05**	**CO5**
06	**Emerging & Advanced Topics** VPN (Virtual Private Networks) - Types and basic principle. Software-Defined Networking (SDN): Concepts, Control and Data Planes, OpenFlow protocols and controllers. Network Function Virtualization (NFV): Concepts and Benefits, Data Center Networks (DCNs): Topologies (Fat Tree - Concept) **Self-learning:** SD-WAN	**06**	**CO6**

Text Books:

1. Fourauzan B., "Data Communications and Networking", 5th Edition, Tata McGraw-Hill, Publications, ISBN:0–07 – 058408 – 7
2. Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson India, 2012.
3. A. S. Godbole and A. Kahate, Data Communications & Networks, 2nd ed. New Delhi: McGraw Hill Education, 2011.

References:

1. Kurose, Ross, "Computer Networking a Top Down Approach Featuring the Internet", Pearson, ISBN-10: 0132856204
2. Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan -Kaufmann, 2012.
3. Douglas E. Comer & M.S Narayanan, "Computer Network & Internet", Pearson Education
4. NPTEL Swayam Course: https://onlinecourses.nptel.ac.in/noc22_cs19/
5. CCNA: Introduction to Networks https://www.netacad.com/courses/ccna-introduction-networks?courseLang=en-US

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPCC502	IoT Architecture and Protocols	20	20	60	1	2	100	

Prerequisite: Computer Networks, Microcontroller ports, timers, basics of C/Python programming.	
Course Objectives: The course aims to	
1	Understand IoT characteristics, conceptual framework and foundational platforms.
2	Comprehend network architecture and design of IoT.
3	Understand smart objects in IoT.
4	Correlate the connection of smart objects and IoT access technologies.
5	Explore network layer and application layer protocols for IoT.
6	Explore IoT security aspect.
Course Outcomes: Learners will be able to	
1	Describe the IoT characteristics, conceptual framework and basic MCU/SBC setup.
2	Differentiate between the levels of the IoT architectures.
3	Interpret sensor network and its components.
4	Analyse the IoT access technologies.
5	Illustrate various protocols at network layer and application layer for IoT.
6	Analyse and evaluate security issues in IoT and risk analysis structure.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to IoT** Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Basics of networking Communication protocol, TCP-IP protocol stack (with IoT examples: MQTT/TCP+TLS, CoAP/UDP+DTLS), wireless sensor networks (WSN) overview. Convergence of IT and OT, IoT Challenges, IoT protocol vs Web Protocol stack **Self-learning Topics**: Hardware and software development tools for - Arduino, NodeMCU, ESP32, Raspberry Pi / R-Pi pico.	6	CO1
02	**IoT Network Architecture and Design** Drivers Behind New Network Architectures - Scale, Security, Constrained Devices and Networks, Data, Legacy Device Support. Architecture - The IoT World Forum (IoTWF) Standardized Architecture: Layer 1-7, IT and OT Responsibilities in the IoT Reference Model, Additional IoT Reference Models, A Simplified IoT Architecture, The Core IoT Functional Stack: Layer 1-3, Analytics Versus Control Applications, Data Versus Network Analytics, Data Analytics Versus Business Benefits, Smart Services. IoT Data Management and Compute Stack - Fog Computing, Edge Computing. The Hierarchy of Edge, Fog, and Cloud.	6	CO2

03	**Smart Objects in IoT** Sensors, Actuators, and Smart Objects. Micro-Electro-Mechanical Systems (MEMS) for Smart Objects - Definition & Trends. Sensor Networks & WSNs - WSN Protocols (link/network layer); RFID & NFC (short-range ID)	**8**	**CO3**
04	**Connecting Smart Objects** Communications Criteria - Range, Frequency Bands, Power Consumption, Topology, Constrained Devices, Constrained-Node Networks, Data Rate and Throughput, Latency and Determinism, Overhead and Payload. IoT Access Technologies - Standardization and Alliances, Physical Layer, MAC Layer, Topology, Security and Conclusion of IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, NB-IoT and Other LTE Variations: LTE Cat 0, LTE-M. **Self-learning Topics**: Case studies on selecting IoT access technologies based on different communication criteria.	**8**	**CO4**
05	**IoT Network and Application Layer protocols** The Business Case for IP, The Key Advantages of Internet Protocol, Adoption or Adaptation of the Internet Protocol, The Need for Optimization, Constrained Nodes, Constrained Networks IP Versions, Optimizing IP for IoT. From 6LoWPAN to 6Lo, Header Compression, Fragmentation, Mesh Addressing, Mesh-Under Versus Mesh-Over Routing, 6Lo Working Group, 6TiSCH, RPL (Objective Function, Rank, RPL Headers, Metrics), Authentication and Encryption on Constrained Nodes - ACE and DICE, Profiles and Compliances, Internet Protocol for Smart Objects Alliance - Wi-SUN Alliance, Thread, IPv6 Ready Logo. The Transport Layer, IoT Application Transport Methods, Generic Web-Based Protocols. IoT Application Layer Protocols- CoAP, MQTT, AMQP.	**8**	**CO5**
06	**Securing IoT** A Brief History of OT Security. Common Challenges in OT Security - Erosion of Network Architecture, Pervasive Legacy Systems, Insecure Operational Protocols. Security Knowledge - IT and OT Security Practices and Systems Variations. The Purdue Model for Control Hierarchy, OT Network Characteristics Impacting Security, Security Priorities- CIA, Security Focus. Formal Risk Analysis Structures- OCTAVE and FAIR. **Self-Learning Topic**: OWASP IoT Top 10 attacks, X.509, SSL & TLS basics	**6**	**CO6**

Text Books:

1. Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.

Reference Books:

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC press.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT) Ecosystem: Insight Paradigm, Springer.

Online References:

1. https://owasp.org/www-project-internet-of-things/
2. https://www.theiotacademy.co/blog/esp-8266-vs-esp-32/
3. https://www.raspberrypi.com/documentation/
4. https://docs.arduino.cc/programming/
5. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
6. NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPCC503	Machine Learning	20	20	60	1	2	100	

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives: The course aims to	
1	Introduce the basic concepts and techniques of Machine Learning.
2	Learn and implement various supervised and unsupervised Machine Learning algorithms.
3	Acquire in depth understanding of classification and regression techniques.
4	Analyse and evaluate the performance of ML models.
Course Outcomes: Learners will be able to	
1	Apply appropriate data pre-processing techniques to transform raw data into suitable formats for machine learning algorithms.
2	Explain and implement regression and decision tree models for predictive data analysis and model building.
3	Apply ensemble learning techniques to combine multiple models and enhance predictive performance.
4	Develop and evaluate classification models using suitable algorithms and performance metrics.
5	Apply and compare advanced clustering methods to uncover patterns and solve complex unsupervised learning problems.
6	Demonstrate dimensionality reduction and feature extraction methods to improve learning efficiency and model performance.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundations of Machine Learning** Overview of Machine Learning: What is Machine Learning, Types of Machine Learning: Supervised, Unsupervised, Semi-supervised, Reinforcement (overview), Issues and Challenges in Machine Learning, Applications of Machine Learning, Steps in Developing a Machine Learning Application. Fundamentals of Model Learning: Training Error and Generalization Error, Overfitting and Underfitting, Bias–Variance Trade-off. Data Preprocessing: Handling Missing and Categorical Data, Feature Scaling (Normalization, Standardization), Partitioning Dataset (Training/Test Split) Feature Selection and Data Quality Considerations.	6	CO1
02	**Regression and Decision Tree Models** Learning with Regression: Linear Regression and Multivariate Linear Regression, Logistic Regression, Regularization Techniques: Ridge and Lasso (Introduction). Learning with Trees: Decision Trees: Concepts and Structure, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART), Stopping Criteria and Pruning. Model Evaluation and Performance Metrics: Confusion Matrix, Sensitivity, Specificity, Precision, Recall, F-measure, ROC Curve and Area Under Curve (AUC). **Self-Learning Topic:** Kappa Statistics**.**	9	CO2

03	**Ensemble Learning Techniques** Foundations of Ensemble Methods: Understanding Ensembles and the Bias–Variance Relationship, K-fold Cross Validation, Bagging, Subagging, and Random Forests. Boosting Techniques: Boosting and Stumping, AdaBoost and Gradient Boosting, XGBoost: Overview and Applications, Comparison between Bagging and Boosting, Different Ways to Combine Classifiers.	**7**	**CO3**
04	**Classification Methods and Support Vector Machines** Support Vector Machines (SVM): Motivation and Need for SVM, Constrained Optimization and Optimal Decision Boundary, Margins and Support Vectors, SVM as a Constrained Optimization Problem, Quadratic Programming Formulation, SVM for Linear and Nonlinear Classification, Basics of Kernel Trick. Advanced Topics in Classification: Multiclass Classification Approaches, Naïve Bayes Classifier.	**7**	**CO4**
05	**Clustering and Unsupervised Learning** Introduction to Clustering: Overview of Distance Metrics (Euclidean, Manhattan, Cosine, etc.), Major Clustering Approaches and Applications, K-Means Clustering: Algorithm, Initialization, and Convergence. Advanced Clustering Methods: Graph-Based Clustering: Minimal Spanning Tree Approach, Model-Based Clustering: Density-Based Clustering: DBSCAN, Comparison of Clustering Methods. **Self-Learning Topic:** Applications of clustering	**8**	**CO5**
06	**Dimensionality Reduction and Feature Extraction** Introduction to the Curse of Dimensionality, Feature Selection vs Feature Extraction, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Singular Value Decomposition (SVD), Applications of Dimensionality Reduction in Machine Learning.	**5**	**CO6**

Text Books:

1. Mitchell, Tom M., "Machine Learning," McGraw-Hill Education (India) Private Limited, 2013.
2. Alpaydin, Ethem, "Introduction to Machine Learning (Adaptive Computation & Machine Learning)," MIT Press, 2nd Edition, 2009
3. Shai Shalev-Shwartz; Shai Ben-David, MACHINE LEARNING From Theory to Algorithms, Cambridge University Press, 2014.

References:

1. Hastie, T., Tibshirani, R., and Friedman, J. H., "The Elements of Statistical Learning: Data Mining, Inference, and Prediction," Second Edition, Springer, 2009 (freely available online).
2. Sebastian Raschka; Yuxi (Hayden) Liu, Vahid Mirjalili, Machine Learning with PyTorch and Scikit-Learn, PackT, 2022.
3. Python Machine Learning - Third Edition: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, Packt Publishing Limited, 2019.
4. Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
5. NPTEL Course Link: https://onlinecourses.nptel.ac.in/noc25_cs91/preview
6. Udemy Course- Machine Learning & Deep Learning in Python & R: https://www.udemy.com/course/data_science_a_to_z/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)
Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)
End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC5011	Web-X	20	20	60	1	2	100	

Prerequisite: Full stack Java	
Course Objectives: The course aims to	
1	Understand web evolution, traditional and modern architectures, and design patterns.
2	Develop interactive front-end applications using Angular and TypeScript.
3	Design secure and scalable back-end APIs using Node.js, Express.js.
4	Explore cloud deployment, DevOps, and AI for intelligent web systems
Course Outcomes: Learners will be able to	
1	Explain web evolution and analyse modern web architectures and design patterns.
2	Build dynamic user interfaces using Angular components and TypeScript.
3	Develop RESTful APIs with Node.js and implement authentication and security.
4	Integrate SQL/NoSQL databases for backend data management and analytics.
5	Deploy and manage applications using cloud platforms, Docker.
6	Create AI-driven web applications with real-time features.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Web Evolution & Architecture** Web Evolution-Web 1.0 → Static Web, Web 2.0 → Dynamic & Social Web (AJAX, APIs), Web 3.0 → Decentralized & Semantic Web. Traditional Architectures Client–Server, 2-Tier, 3-Tier, N-Tier Models, Roles of presentation, logic, and data layers, Modern Design Patterns. MVC / MVVM (Model–View–Controller, Model–View–View Model), Component-based Architecture, SPA (Single Page Applications) and Virtual DOM, RESTful Architecture and stateless APIs, Emerging Architectures Progressive Web Apps (PWA) — caching, manifest, service workers, Cloud-Native Design — microservices, containerization. **Self-Learning Topic:** Serverless and Edge Computing Architectures in Modern Web Development.	7	CO1
02	**Modern Front-End Frameworks Overview** Overview of Angular: architecture, components, templates, and data binding, Angular CLI basics – project setup and structure TypeScript Essentials for Angular: Why TypeScript is used in Angular, Type annotations, interfaces, and classes. Angular Directives, Routing & State Management, Angular Router: configuring routes and navigation, React Router: conceptual comparison, Context API (React) and Services / DI (Angular) for state sharing, Build Tools & Styling Vite project setup and npm scripts, Tailwind CSS utility classes and styling in Angular **Self-Learning Topic:** Performance Optimization and Lazy Loading in Angular Applications, State Management using NgRx and Redux Patterns.	9	CO2
03	**Back-End Development & API Engineering** Node.js Core: Event loop, callbacks, NPM packages. Express.js Framework: Routing, middleware, controllers, error handling.	6	CO3

	API Design: REST methods, status codes, versioning. Microservices Basics: Service isolation, API gateway concepts, communication patterns, Containerization with Docker (overview only). Testing & Debugging: Postman collections, nodemon, dotenv.		
04	**Advanced Database Technologies** PostgreSQL fundamentals: SQL queries, Integrating Node.js/Express with PostgreSQL. NoSQL Databases (MongoDB)*:* Collections, documents, CRUD operations, Aggregation pipelines for analytics queries. Cloud & Real-Time Databases*:* Firebase Realtime Database & Firestore for live data sync, Supabase (PostgreSQL + Realtime APIs), DuckDB for in-browser and local analytics processing.	**8**	**CO4**
05	**Cloud Computing & DevOps** Cloud Platforms Overview: AWS EC2/S3, Google Cloud, Vercel, Render, Firebase Hosting. Serverless Computing**:** AWS Lambda, Firebase Functions (basic deploy). Containerization: Docker concepts, Dockerfile, image build/run.	**6**	**CO5**
06	**AI-powered web applications** AI in Web Apps: OpenAI API, Hugging Face API integration. Data Pipelines & Dashboards: Web scr aping with Python/Node, data visualization (Chart.js). Real-Time Communication: WebSocket vs HTTP, Socket.io demo, MQTT basics for IoT.	**6**	**CO6**

Text Books:

1. Ethan Brown, "Web Development with Node and Express: Leveraging the JavaScript Stack", 2nd Edition, O'Reilly Media, 2019.
2. Minko Gechev, **"Angular: Up and Running"**, 2nd Edition, O'Reilly Media, 2021.
3. Alan Beaulieu, "Learning SQL", 3rd Edition, O'Reilly Media, 2020.

References:

1. S. Subramanian, "Full Stack Web Development: With Angular and Node.js", McGraw-Hill, 2020.
2. Martin Kleppmann, "Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems", O'Reilly Media, 2017.
3. Kelsey Hightower, Brendan Burns, Joe Beda, "Kubernetes: Up and Running – Dive into the Future of Infrastructure", 3rd Edition, O'Reilly Media, 2023.
4. Gene Kim, Jez Humble, Patrick Debois, John Willis, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations", IT Revolution Press, 2021.
5. https://www.coursera.org/specializations/web-design

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC5012	Computational Theory and Compiler Design	20	20	60	1	2	100	

Prerequisite: Basic concepts of Analysis of Algorithm and Discrete Structures	
Course Objectives: The course aims to	
1	Build concepts of theoretical design of Deterministic, Non-deterministic Finite Automata and Pushdown Automata
2	Acquire conceptual understanding of fundamentals of grammars and languages
3	Develop understanding of different types of Turing machines and concept of undecidability
4	Gain knowledge of compiler structure, parsing, intermediate code generation and code optimization
Course Outcomes: Learners will be able to	
1	Design Deterministic and Non-deterministic Finite Automata for regular languages and construct equivalent regular expressions
2	Analyse and apply regular grammar and context-free grammar for various languages
3	Design Pushdown Automata for context-free language
4	Understand computation through Turing Machine and undecidability concepts
5	Demonstrate structure, phases of a compiler and learn various parsing techniques.
6	Apply code generation and optimization techniques to improve program efficiency

Module	Detailed Contents	Hrs.	CO Mapping
01	**Finite Automata and Regular Expressions** Importance o f Theory of Computation, Closure properties, Finite Automata (FA) and Finite State Machines (FSM), Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA) - Definitions, transition diagrams and Language recognizers, Equivalence of NFA and DFA, ε-transitions, NFA to DFA conversion, DFA minimization, Applications of FA. Regular Expressions (RE), Equivalence of RE and FA, Arden's Theorem, RE applications. Regular Languages (RL) - Closure and decision properties, Pumping Lemma for RLs. **Self Learning Topic:** FSM with output - Moore and Mealy machines	**10**	**CO1**
02	**Grammars** Grammars and Chomsky hierarchy, Regular Grammar (RG), Equivalence of RG and FA, Context-Free Grammars (CFG) - Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications.	**07**	**CO2**

	Chomsky Normal Form (CNF) and Greibach Normal Form (GNF), Context-Free Languages (CFL) - Closure properties and CFL Pumping Lemma.		
03	**Pushdown Automata** Pushdown Automata (PDA) - Definition, transition functions, PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	**04**	**CO3**
04	**Turing Machine and Undecidability** Definition of Turing Machine (TM), Design of TM as generator, decider and acceptor, Variants of TM - Multitrack, Multitape, Universal TM. Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem.	**06**	**CO4**
05	**Compiler Structure and Parsing** Structure of Compiler, Phases of Compiler, Lexical Analysis, Role of Lexical Analyzer. Parsing, Role of Parser, Top-Down Parsing, LL(1) grammar (FIRST and FOLLOW), Syntax Directed Translation, Syntax Directed Definitions, Bottom up Parsing, LR Parsers (SLR, CLR and LALR), implementation of LR Parser	**08**	**CO5**
06	**Intermediate Code Generation and Code Optimization** Intermediate Code, Three address code, SDTs for Grammar with example, Code Generation, Labelling Algorithm, DAG, Code Optimization, Dominator, Reducible Flow Graph, Runtime Environment Management, Storage Organization. Intermediate Code Generation, Properties of code Improving Transformation, Data Flow, Data Flow analysis in code Optimization, Algorithm to compute IN and OUT Parameter.	**07**	**CO6**

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages and Computation", 3rd Edition, Pearson Education, 2008.
2. Michael Sipser, "Theory of Computation", 3rd Edition, Cengage learning. 2013.
3. Compilers: Principles, Techniques, & Tools 2nd Edition Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman Pearson Education 2007
4. Basics of Compiler Design 2nd Edition Torben Egidius Mogensen DIKU, University of Copenhagen 2007

References:

1. J. C. Martin, "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill Publication, 2013.
2. Modern Compiler Design 2nd Edition Dick Grune, Kees van Reeuwijk, Henri E. Bal, Ceriel J.H. Jacobs, Koen Langendoen Springer Science+Business Media New York 2012
3. Vivek Kulkarni, "Theory of Computation", Illustrated Edition, Oxford University Press, (12 April 2013) India.
4. https://onlinecourses.nptel.ac.in/noc25_cs121/preview
5. https://www.udemy.com/course/the-complete-theory-of-computation/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

3. Assignment: 5 Marks
4. Quiz/Open book test/Presentation: 10 Marks
5. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC5013	Data Analytics and Visualization	20	20	60	1	2	100	

Prerequisite: DBMS, Python programming	
Course Objectives: The course aims to	
1	Introduce fundamental concepts, lifecycle, and processes of data analytics, and its role in decision-making.
2	Provide understanding of transactional vs analytical systems, analytical schema design (star, snowflake, fact tables), and foundational concepts in IPD and KDD workflows.
3	Develop analytical and problem-solving skills through data mining, time series forecasting, and text analytics for real-world data interpretation
4	Enable proficiency in data visualization, cloud-based tools, BI platforms, and ethical, AI-driven analytics practices for industry applications
Course Outcomes: Learners will be able to	
1	Explain the concepts, lifecycle, and types of analytics, and differentiate between Data Analytics, Data Science, and Big Data.
2	Understand OLTP vs analytical systems, design warehouse schemas, interpret IPDs, and apply KDD for deriving insights.
3	Apply data mining algorithms such as Apriori and FP-Growth to discover patterns and relationships in large datasets.
4	Analyse time series and text data to identify trends, perform forecasting, and extract sentiment or thematic insights.
5	Create interactive data visualizations and dashboards using Python, R, and BI tools for effective storytelling.
6	Demonstrate understanding of cloud-based BI solutions, pipeline automation (Airflow, CI/CD), and AI-driven analytics tools like Power BI Copilot and Tableau GPT

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Data Analytics** Fundamentals of Data Analytics: Definition, scope, and importance of Data Analytics. Types of Analytics – Descriptive, Predictive, and Prescriptive. Comparison between Data Analytics, Data Science, and Big Data. Key roles and responsibilities in analytics projects. Data Analytics Lifecycle: Phases of the Data Analytics Lifecycle: Discovery: Understanding business objectives, framing analytical problems, and identifying stakeholders. Data Preparation: ETL (Extract, Transform, Load) operations, data cleaning, and feature preparation. Model Planning:	08	CO1

	Data exploration, variable selection, and model strategy. Model Building: Implementing analytical or machine learning models. Communicating Results: Visualization, interpretation, and reporting insights. Operationalization: Deployment, performance tracking, and model maintenance.		
02	**Foundations of Analytical Systems, Schema Modeling, and Knowledge Discovery** Introduction to Data Warehousing: OLTP vs OLAP Systems. Data Warehouse Schemas: Star Schema, Snowflake Schema, Fact Constellation, Fact Table, Dimension Table, and Factless Fact Table Information Package Diagram (IPD). Knowledge Discovery in Databases (KDD) Overview	**05**	**CO2**
03	**Data Mining and Association Analysis** Introduction to Data Mining and its Applications: Basket Analysis and Association Rule Mining. Apriori Algorithm: Generation of Frequent Itemsets and Association Rules Metrics: Support, Confidence. Improving Efficiency of Apriori and FP-Growth Concept. Mining Multilevel and Multidimensional Association Rules	**07**	**CO3**
04	**Time Series and Text Analytics** Introduction to Time Series Data and Components: AR, MA, and ARIMA Models – Conceptual Overview. Evaluating and Interpreting Time Series Patterns. Introduction to Text Analytics and Natural Language Data. Steps in Text Analytics: Text Collection, Tokenization, TF–IDF Text Categorization, Sentiment Analysis, and Applications **Self Learning Topic**: Building a Sales Forecasting Model using ARIMA in Python, Performing Sentiment Analysis on Twitter Data using VADER/TextBlob	**06**	**CO4**
05	**Data Visualization and Business Intelligence Tools** Introduction to Data Visualization: Principles and Importance Data Visualization using Python: Libraries: Pandas, NumPy, Matplotlib, Seaborn. Basic Plots: Histogram, Bar Chart, Pie Chart, Box and Violin Plots. Relationship Visualization: Pairplot, Regression Plot (regplot) Visualization using R: Data Import/Export, Descriptive Statistics, Visualization before Analysis **Self Learning Topic:** Building an Interactive Dashboard in Power BI or Tableau Public.	**07**	**CO5**
06	**Modern Cloud, Automation, and AI-Driven Analytics** Overview of BI Implementations on AWS, Azure, and Google Cloud. Comparison of Cloud Data Warehouses: Snowflake, BigQuery Amazon Redshift – architecture, pricing, and scalability. Real-Time and Streaming Analytics: Building Dashboards with Live Data using Kafka, Power BI Streaming or Grafana. Streaming Data Ingestion, Transformation and Monitoring. AI-Driven BI Tools: Exploring Power BI Copilot, Tableau GPT, and Qlik Sense AI.	**09**	**CO6**

Text Books:

1. Daniel T. Larose, Chantal D. Larose, “Data Science Using Python and R”, 2nd Edition, Wiley, 2015.
2. R. Kimball, M. Ross, “The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling”, 3rd Edition, Wiley, 2013.
3. Nathan Yau, “Data Points: Visualization That Means Something”, 2nd Edition, Wiley, 2011.

References:

1. Alberto Boschetti, E. Pagnotta, “Practical Time Series Analysis: Master Time Series Data Processing, Visualization, and Modeling Using Python”, 2nd Edition, Packt Publishing, 2021.
2. Alex Galea, “Data Visualization with Python and JavaScript: Scrape, Clean, Explore & Transform Your Data”, 1st Edition, O’Reilly Media, 2018
3. Barton Poulson, “Business Intelligence and Analytics: Systems for Decision Support”, 2nd Edition, Pearson Education, 2019
4. https://onlinecourses.nptel.ac.in/noc25_mg87/preview
5. https://onlinecourses.nptel.ac.in/noc25_mg88/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
CEMDM501	Database Management System	20	20	60	1	2	100	

Course Objectives: The course aims to	
1	Learn and practice data modelling using the entity-relationship and developing database designs.
2	Implement the use of Structured Query Language (SQL) and learn SQL syntax.
3	Illustrate the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4	Analyse the concept of database security and privacy
Course Outcomes: Learners will be able to	
1	Describe the fundamentals of database systems
2	Implement the different data models and design issues in database.
3	Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4	Analyse the basics model of relational Algebra, calculus.
5	Experiment views, triggers and querying the database using SQL.
6	Implement transaction management, concurrency control. database security and privacy

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Databases** Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, three tier database architecture, Data independence	4	CO1
02	**Data Models** The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	3	CO2
03	**Database Design, ER-Diagram and Unified Modelling Language** Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	10	CO3
04	**Relational Algebra and Calculus** Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	10	CO4

05	**Constraints, Views and SQL** What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	10	**CO5**
06	**Transaction management and Concurrency control** Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy: Issues, Access Control based on grant and revoke privileges	5	**CO6**

Text Books:

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

References:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
5. Debabrata Sahoo "Database Management Systems‖ Tata McGraw Hill, Schaum
6. https://www.w3schools.in/dbms/
7. https://www.tutorialspoint.com/dbms/index.htm
8. https://www.studytonight.com/dbms/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETMDM501	Digital Communication & Sensor Technology	20	20	60	1	2	100	

Prerequisite: Basic Electronics and Electrical Engineering, Discrete mathematics fundamentals	
Course Objectives: The course aims to	
1	Develop a foundational understanding of digital communication systems, including their key components and underlying principles.
2	Analyze the techniques of source coding, channel capacity, error control, and the transmission of digital signals over communication channels.
3	Understand sensor types, key parameters, and their integration with digital systems.
4	Introduce concepts of inductive and capacitive transducers, and microsensors & micro-actuators, for practical application in measurement and control systems.
Course Outcomes: Learners will be able to	
1	Describe the basic structure of a digital communication system and explain key channel parameters and transmission types.
2	Analyse the implications of Shannon-Hartley Capacity theorem while designing the efficient Source encoding technique.
3	Explain the concept and need for designing efficient Forward Error Correcting codes.
4	Understand the impact of inter-symbol interference (ISI) in baseband transmission and evaluate various digital modulation techniques.
5	Understand appropriate sensors and design corresponding signal-conditioning circuits based on their key characteristics such as range, resolution, sensitivity, and accuracy.
6	Describe the principles, construction, characteristics, and applications of inductive, capacitive, and micro sensors used for measurement and instrumentation.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Digital Communication Systems** Elements of basic digital communication system, Communication channel characteristics: bit rate, baud rate, bandwidth, repeater distance, Advantages and disadvantages of Digital transmission, significance of digitization: PCM encoding of voice and image signals	04	CO1
02	**Information Theory and Source Coding** Measure of Information, Entropy, Information rate, Channel capacity, Shannon-Hartley Capacity Theorem and its Implications, Source coding: Huffman coding, Code Efficiency & Redundancy **Self-Learning Topic:** Study how source coding reduces data size in practical file compression and transmission.	06	CO2

03	**Channel Coding** Need for channel encoding, Concept of Error detection and correction, Forward Error correction Linear block codes: Hamming Distance, Hamming Weight, Systematic codes, Syndrome, Cyclic codes: Generator polynomial for Cyclic codes, Systematic cyclic codes Convolution codes: Convolution encoder, Impulse response of encoder	**06**	**CO3**
04	**Digital Transmission Fundamentals & Modulation Strategies** Digital Transmission Fundamentals: Baseband and Passband Transmission, Line codes and their desirable properties, PSD of digital data, Baseband PAM transmission: Concept of Inter symbol interference (ISI), Eye diagram Types of digital modulation techniques and their advantages; concept of coherent vs. non-coherent detection Shift-keying techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Differential Phase Shift Keying (DPSK), Quadrature Phase Shift Keying (QPSK): Types, Quadrature Amplitude Modulation (QAM): block diagrams of transmitter/receiver, working principle, key waveforms & constellation diagrams **Self-Learning Topic**: M-ary encoding: M-ary FSK and M-ary PSK	**12**	**CO4**
05	**Fundamentals of Sensor Technology** Introduction to Sensors, Classification, Selection, and Characteristics of Sensors: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy Primary Sensing Elements and Signal Conditioning, Principles, Construction, and Applications of Common Sensors (potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor).	**06**	**CO5**
06	**Transducer and Microsensor Technologies** Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: capacitor microphone, capacitive pressure sensor, proximity sensor Micro Sensors and Micro Actuators: Principles, Types and examples **Self-Learning Topic:** Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors	**08**	**CO6**

Text Books:

1. H. Taub, D. Schlling, and G. Saha-Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.
3. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
4. Patranabis.D, “Sensors and Transducers”, Wheeler publisher, 1994.

References:

1. T L Singal-Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.
3. Sergej Fatikow and Ulrich Rembold, "Microsystem Technology and Microbotics", First edition, Springer –Verlag NEwyork, Inc, 1997.
4. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
5. NPTEL : https://nptel.ac.in/courses/108102120
6. NPTEL :https://nptel.ac.in/courses/108106193

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ARMDM501	Mechatronics	20	20	60	1	2	100	

Prerequisite: Fundamentals of Electrical & Electronics Engineering, Basics of Sensors & Instrumentation	
Course Objectives: The course aims to	
1	Study key elements of the Mechatronics system.
2	Familiarise with concepts of sensor characterisation, actuators and their interfacing with microcontrollers.
3	Introduce ADC/DAC conversion and basic signal filtering concepts
4	Study the design of pneumatic and hydraulic circuits.
5	Study and understand electropneumatic circuits and PLC Design
6	Demonstrate system reliability, communication interfaces and real mechatronic system integration.
Course Outcomes: Learners will be able to	
1	Explain elements of the mechatronics systems and the mechatronics design process
2	Identify the suitable sensor and actuator for a mechatronics system
3	Analyze ADC/DAC processes and apply suitable signal filtering techniques for measurement systems.
4	Design & develop pneumatic/hydraulic circuits.
5	Design and develop electropneumatic circuits and PLC ladder logics.
6	Interpret system reliability aspects, communication interfaces and industrial case studies of mechatronic systems.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Mechatronics** 1.1. Definition, scope and evolution of Mechatronics, Key elements of Mechatronic system (mechanical structure, sensors, actuators, electronics, control unit, software), 1.2. Integrated design approach in Mechatronics vs conventional design, Mechatronics design process (problem identification, modelling, simulation, prototyping, implementation) **Self-Learning Topic:** Real-life mechatronic system identification (elevator, printer, washing machine, etc.	05	CO1
02	**Selection of Sensors & Actuators** 2.1. Sensors: Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart, etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics.	07	CO2

	2.2. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety, etc. Principle and selection of mechano-electrical actuators, i) DC motors, ii) Stepper Motors, iii) Solenoid Actuators, iv) Servo Motors, v) BLDC		
	Self-Learning Topic: Examples of sensors used in household appliances (fridge, washing machine, AC), Comparison of DC motor vs Stepper motor in simple applications, Selection of an actuator for a small robotic arm		
03	**Data Acquisition, Signal Conditioning & Microcontroller System Theory**	**07**	**CO3**
	3.1. Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Converter), Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Converter), R-2R circuit and DAC resolution 3.2. Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases		
	Self-Learning Topic: Use of low-pass filter in removing noise from a sensor signal, Applications of band-pass filters		
04	**Design of Pneumatic & Hydraulic Circuits**	**08**	**CO4**
	4.1. Design of Pneumatic Sequencing Circuits using the Cascade method and the shift register method (up to 2 cylinders) 4.2. Basic Hydraulic Circuits: Meter in, meter out, and bleed off circuits; Intensifier circuits, Regenerative Circuit, Counterbalance valve circuit and sequencing circuits.		
	Self-Learning Topic: Identification of hydraulic circuits used in industry (press machines, lifting systems), Simple case study of meter-in vs meter-out control in hydraulic actuators, Safety precautions in handling hydraulic and pneumatic systems		
05	**Design of Electro-pneumatic Circuits**	**08**	**CO5**
	5.1. Electro-pneumatic Circuits Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves, with and without grouping. 5.2. PLC Discrete Control Systems Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.		
	Self-Learning Topic: Identification of electro-pneumatic components used in industrial machines, Real-life examples of pneumatic systems in automation, Safety rules and precautions when working with pneumatic circuits		
06	**Reliability, communication, and Case studies**	**07**	**CO6**
	6.1. Reliability, maintainability, safety, and fault diagnosis in mechatronic systems 6.2. Communication Protocols (overview only), CAN, UART, SPI, I2C (basics only) 6.3. Case Studies: Automotive ABS, CNC feed drive system, Pick & place robot, Smart manufacturing cell		

Text Books:

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design, Shetty and Kolk, Cengage Learning, India Edition
3. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
4. Pneumatic Circuits and Low-Cost Automation by Fawcett JR
5. Electromechanical Design Handbook, Walsh, McGraw-Hill
6. Electro-mechanical Engineering - An Integrated Approach, Fraser and Milne
7. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition

References:

1. Industrial Hydraulics: Pippenger
2. Vickers Manual on Hydraulics
3. Hydraulic Valves and Controls: Pippenger
4. Fundamentals of pneumatics: Festo series
5. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
6. Mechatronics, HMT
7. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.

NPTEL/SWAYAM courses:

a. https://onlinecourses.nptel.ac.in/noc21_me27/preview
b. https://nptel.ac.in/courses/117105082

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to the Mid Semester Examination (MSE), carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE, carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ITMDM501	Sensors Actuators and Transducers	20	20	60	1	2	100	

Prerequisite: Students should be able to implement the fundamental knowledge of the IoT system.	
Course Objectives: The course aims to	
1	To understand the working principles and classifications of sensors, actuators, and transducers.
2	To learn micro and MEMS sensors and actuators for IoT systems.
3	To study electrical interfacing, signal conditioning, and calibration techniques.
4	To design IoT-based systems using real-time sensing and actuation.
Course Outcomes: Upon successful completion of this course, the learner will be able	
1	Explain operating principles and classifications of sensors, actuators, and transducers.
2	Identify and select appropriate sensors for various IoT applications.
3	Describe actuator types and their control techniques.
4	Explain transduction mechanisms and their practical implementation.
5	Design and implement IoT-based systems integrating sensors, actuators, and transducers.
6	Understand the concept of Advanced transducers and their IoT integration

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamentals and Classification of Sensors:** **1.1** Introduction to sensors and measurement systems. **1.2** Sensor characteristics: sensitivity, resolution, accuracy, range, hysteresis, drift, and linearity. **1.3** Classification: active/passive, analog/digital, contact/non-contact sensors. **1.4** Types of sensors for measurement of : flow, temperature, pressure, proximity, force/strain, speed/velocity, displacement/position, acceleration/motion, sound, vibration, humidity, gas, biosensor, pH, infrared, image/vision **1.5** Selection criteria and standards for sensors. **1.6** Overview of smart sensors and IoT sensor nodes. **1.7** Applications: Home automation, smart lighting, temperature monitoring **Self-Learning Topic:** Application for moisture measurement	08	CO1
02	**Micro and MEMS Sensors for IoT:** **2.1** Introduction to MEMS and micro-sensors. **2.2** MEMS fabrication techniques (lithography, etching, deposition, packaging)	06	CO2

	2.3 Micro-sensors: ● Accelerometer, gyroscope, pressure, flow, temperature, and humidity sensors ● Biosensors and chemical sensors **2.4** Integration of MEMS sensors in IoT platforms (smartphones, wearables, vehicles) **2.5** Sensor calibration, signal conditioning, and interfacing.		
	Self- Learning Topic: Case Study: MPU6050 IMU, BMP280 environmental sensor, DHT11		
03	**Fundamentals of Actuators and Drive Mechanisms**	**08**	**CO3**
	3.1 Introduction to actuators – principle, classification, and characteristics **3.2** Electrical actuators: o DC motor, stepper motor, servo motor o Control techniques (PWM, H-bridge) **3.3** Pneumatic and hydraulic actuators – basic operation and control valves. **3.4** Mechanical actuators- operation and types and control circuit. **3.5** Smart actuators and drive circuits for IoT. **3.6** Thermal actuators- basic operation and control circuit. **3.7** Magnetic actuator-basic operation and control circuit **3.8 Applications:** Smart door locks, automatic fans.		
	Self-Learning Topic: Application in robotic arms		
04	**Micro-Actuators and Intelligent Actuation Systems**	**06**	**CO4**
	4.1 MEMS micro-actuators: electrostatic, piezoelectric, thermal, and magnetic types. **4.2** Shape memory alloy (SMA) actuators. **4.3** Micro-pumps, micro-valves, and micro-grippers. **4.4** Interfacing actuators with microcontrollers and IoT boards (Arduino, ESP32, Raspberry Pi)		
	Self-Learning Topic: Case studies: micro-actuators in biomedical devices and robotics		
05	**Transducer Fundamentals and Signal Conditioning:**	**07**	**CO5**
	5.1 Concept of transduction and transducers **5.2** Types of transduction mechanisms: resistive, inductive, capacitive, piezoelectric, and optical. **5.3** Conversion principles and energy domains. **5.4** Static and dynamic characteristics of transducers. **5.5** Signal conditioning: amplification, filtering, isolation, ADC/DAC, noise reduction. **5.6 Applications:** Strain measurement, pressure.		
	Self-Learning Topic: Application in force detection.		
06	**Advanced Transducers and IoT Integration**		

	6.1 Optical fiber, ultrasonic, and photoelectric transducers. **6.2** Smart and digital transducers. **6.3** Wireless transducer networks and IoT interfacing. **6.4** Calibration, compensation, and error analysis. **6.5** Data acquisition systems and sensor fusion. **6.6** Cloud-based monitoring (Thing Speak, Blynk, MQTT).	**07**	**CO6**
	Self -Learning Topic: Case Studies: Smart agricultural sensing system and IoT-enabled vibration and air-quality transducer networks.		

Text Books

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill
2. Arshdeep Bahga & Vijay Madisetti, Internet of Things: A Hands-On Approach
3. Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, CRC Press

References:

1. Franky Hillenbrand, MEMS Sensors and Actuators, Springer
2. John G. Webster, Measurement, Instrumentation, and Sensors Handbook
3. Misra, A Mukharjee, A Roy, " Introduction to IoT", Cambridge University Press
4. A. Mukharjee, C. Roy , Sudip Misra, "Introduction to Industrial Internet of Things and Industry 4.0".

Website Reference / Video Courses:

1. **NPTEL Course: Introduction to Industrial Internet of Things and Industry 4.0** By Prof. S. Misra , Dept. of Computer Science and Engineering, IIT Kharagpur.:- Web link-

   https://onlinecourses.nptel.ac.in/noc21_cs20/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
MEMDM501	**Conventional & Renewable Energy Sources**	20	20	60	1	2	100	

Prerequisite: Knowledge of Thermal Engineering	
Course Objectives: The course aims to	
1	To study working principles of various renewable energy sources and their utilities
2	To study working principles of various Thermal & Hydro Electric Power plants.
3	To study economics of harnessing energy from renewable energy sources
Course Outcomes: Learners will be able to	
1	Analyze the various energy sources & its availability in India & world.
2	Describe the operating principle of Thermal & hydel power plants.
3	Describe the operating principle of nuclear power plants.
4	Analyze different solar collectors using geometrical parameters and photovoltaics for generation of solar energy & its application
5	Identify and analyze various wind turbine energy harnessing techniques.
6	Identify various Mini & Micro Hydro Electric Plants & wind turbine energy harnessing techniques

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Energy** Types of Energy, energy scenario in India & world, Energy demand & supply & consumption trend.	**05**	**CO1**
02	**Thermal & hydroelectric Power.** Fossil fuels: coal, natural gas formation & use Thermal power generation: basic layout & working., hydro power plants: principal, types & components. Advantages, disadvantages & environmental impacts. **Self-Learning Topic: Hydrology**	**10**	**CO2**
03	**Nuclear Energy** Nuclear fission, fusion, components & layout of Nuclear Power plants, Site Selection. Safety & waste disposal **Self-Learning Topic: Nuclear Materials**	**06**	**CO3**
04	**Solar Energy** Solar Radiation, Sun Earth Angle, Solar Measurement Devices, Solar Energy Collectors. Application of Solar Energy	**08**	**CO4**
05	**Wind Energy** Resources of Wind, Classification of Wind Mills, Wind Energy Conversion System (WECS), Performance Characteristics of Wind Mill, Application of wind energy & Site Selection.	**07**	**CO5**
06	**Other Renewable Energy Sources.**		**CO6**

	Mini & Micro Hydro Electric Plants, Application & Site Selection. Hybrid Energy, Economic Environmental & Regulatory Aspects of Renewable Sources.	**06**	
	Self-Learning Topic: Hydrology		

Text Books:

1. "Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409-073-7
2. "Solar Energy: Principles of Thermal Collection and Storage", SP Sukhatme and J K Nayak, 4th Edition, Tata McGraw Hill Publishing Co. Ltd.
3. "Renewable Energy Sources", J W Twidell& Anthony D. Weir, 3rd Edition 2015,ELBSPub, ISBN: : 978-1-315-76641-6
4. Power Plant Engineering by Prof, V M Domkundwar
5. Power Plant Engineering by Prof Rajput

References:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/103107157
3. https://nptel.ac.in/courses/115105127

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Quiz/Open book test/Presentation: 15 Marks
2. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
EEMDM501	Special Machines and smart grid	20	20	60	1	2	100	

Prerequisite: Student should be able to implement the concept of electrical machines and basics of electrical power system.	
Course Objectives: The course aims to	
1	Understand how to integrate renewable energy sources, such as solar and wind, into both existing and future power grids.
2	Learn the construction, principle of operation, and performance characteristics of various special machines.
3	Identify and understand the applications of special machines and smart grid in modern technology.
Course Outcomes: Upon successful completion of this course, the learner will be able to	
1	Describe the construction, principle of operation, performance characteristics and control schemes of stepper motors.
2	Describe the construction, principle of operation, performance characteristics and control schemes of switched reluctance, motors.
3	Describe the construction, principle of operation, performance characteristics and control schemes of BLDC motor.
4	Describe the construction, principle of operation, performance characteristics and control schemes of PMSM motors.
5	Analyze the necessity and architectures of smart grid.
6	Understand the concept of distributed generation and its operation.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Stepper Motors:**	07	CO1
	1.1 Construction and working principle. 1.2 Types: Variable Reluctance, Permanent Magnet, and Hybrid Stepper Motors. 1.3 Torque–angle characteristics, static and dynamic performance 1.4 Drive and control circuits (unipolar/bipolar, open-loop and closed-loop control) 1.5 Microcontroller or Arduino-based stepper control 1.6 Applications**:** CNC machines, robotics and printers		
	Self-Learning Topic: Application in positioning system		
02	**Switched Reluctance Motors (SRM)**	07	CO2
	2.1 Construction and operating principle 2.2 Torque production and control methods 2.3 Converter topologies for SRM drives 2.4Sensor and sensorless control techniques 2.5 Design and performance considerations 2.6 Applications: Electric vehicles and renewable energy systems		

	Self-Learning Topic: Applications in industrial drives		
03	**Brush less DC Motors (BLDC)** 3.1 Brush less dc motor drive for servo applications. 3.2 Low cost brush less dc motor drives 3.4 Important features 3.5 Applications: Home appliances, EVs **Self-Learning Topic:** Use of PMBLDC in aerospace systems.	**07**	**CO3**
04	**Permanent Magnet Synchronous Motors (PMSM)** **Construction and principle of operation** 4.1 Types: Surface-mounted and Interior PMSMs 4.2 EMF and torque equations 4.3 Vector control (FOC) and direct torque control (DTC) principles **Applications:** Servo systems, robotics, aerospace, traction drives **Self-Learning Topic:** comparison between synchronous motor and PMSM motor.	**07**	**CO4**
05	**Introduction to smart grid:** 5.1 Conventional power systems and Smart grid, definition of smart grid, need for smart grid, 5.2 Smart grid architecture, smart grid domains, enablers of smart grid, 5.3 Communication architecture and protocols for smart grid, smart grid priority standards and regulation. **Self-Learning Topic:** smart-grid activities in India.	**07**	**CO5**
06	**Distributed Generation and communication in Smart Grid:** 6.1 Renewable-based Distributed generations, Introduction to energy storage devices, 6.2 Different types of energy storage technologies, 6.3 Battery management system (BMS): concept, types and applications, 6.4 smart grid communication technologies. **Self-Learning Topic:** need of renewable energy sources.	**07**	**CO6**

Text Books

1. K. Venkataratnam, Special Electrical Machines, Universities Press.
2. E. G. Janardanan, Special Electrical Machines, PHI Learning.
3. Microgrids architectures and control Edited by Nikos Hatziargyriou, Wiley, IEEE Press, 2014.
4. A. Keyhani, M. N. Marwali, M. Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, 2009.
5. Antonio Carlos Zambroni de Souza, Miguel Castilla, Microgrids Design and Implementation, Springer 2019.
6. James Momoh, —Smart Grid: Fundamentals of Design and Analysis, IEEE Press and Wiley Publications, 2015.
7. J. C. Sabonnadière, N. Hadjsaïd, —Smart Grids, Wiley Blackwell.

References:

1. T. J. E. Miller, Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press.
2. R. Krishnan, Electric Motor Drives – Modeling, Analysis and Control, Prentice Hall.
3. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill.
4. G. K. Dubey, Fundamentals of Electrical Drives, Narosa Publications

5. Yezdani, and Reza Iravani, Voltage Source Converters in Power Systems: Modeling, Control and Applications, John Wiley Publications, 2010.
6. Dorin Neacsu, Power Switching Converters: Medium and High Power, CRC Press, 2006.
7. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012.
8. IEEE standards —IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems IEEE standards 2003.
9. IEEE standards —IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System.
10. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS Microgrid Concept'2002.
11. NPTEL Course: DC Microgrid and Control System, Prof. Avik Bhattacharya, IIT Roorkee.

Website Reference / Video Courses:

1. **NPTEL Course: Special Electromechanical Systems by** Prof. S. S. Murthy, Yogesh Hote, Dept. of Electrical Engineering, IIT Delhi.:- Web link- https://nptel.ac.in/courses/108102156
2. **NPTEL Course: Introduction to Smart Grid**, By Prof. N. P. Padhy & Prof. Premalata Jena, IIT Roorkee

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)
Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)
1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)
End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2*+2 Hrs
		Internal Assessment		Oral	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
ICVSEC501	**CyberOps Lab**	-	50	25	-	-	75	

* e-Learning

Course Objectives: The course aims to	
1	Bridge the gap between academic learning and industry skill requirements.
2	Encourage students to complete recognized online certification courses.
3	Provide hands-on exposure in emerging technologies.
4	Promote independent learning, portfolio building, and employability skills.
Course Outcomes: Learners will be able to	
1	Identify and pursue relevant industry skills through online learning platforms.
2	Demonstrate practical understanding of emerging technology.
3	Enhance skills through online certifications.
4	Integrate multiple technical skills in a project.

Learners should select any course from MKCL/ NPTEL/ SWAYAM/ MOOCS/ Infosys Springboard/ Edunet/ Coursera, etc.#
Few suggested certification courses are: Cryptography Basics, Security Operations Center (SOC), Network & Host Defense, Cyber Law & Ethics, Network Security, AI for cyber security, any high-level programming language. The course duration should be **28 to 30 Hours**. #Any other relevant topics in discussion with the concerned faculty.

Continuous Internal Evaluation (50 Marks)

1. Lab Performance: 10 Marks
2. Presentation: 10 Marks
3. Online Certification or Skill Based Project$: 25 Marks
4. Regularity and Attendance: 5 Marks

$ Course project is compulsory for those students who have not enrolled for online certification courses. However, such students have to complete 2 hours of e-learning per week during the college hours. At the end of the Semester, Learner must submit a file containing their Lab performances, Online Certifications/ Course Project report.

Oral Exam (25 Marks)

An Oral exam will be held based on the experiments performed, online Certification Courses/ Skill Based project.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPCL501	**Computer Network and Machine Learning Lab**	-	25	25	-	-	50	

Prerequisite: Operating system, Engineering Mathematics, Data structure	
Course Objectives: The course aims to	
1	Provide practical knowledge of basic networking concepts, commands, topologies, traffic analysis, and routing using simulation tools.
2	Develop the ability in implementing network communication and services through socket programming, error control techniques, and DNS setup.
3	Understand and implement key machine learning techniques, including supervised, unsupervised, and reinforcement learning, using Python.
4	Develop and apply advanced machine learning and optimization methods—such as neural networks, CNNs, RNNs, and genetic algorithms—to real-world predictive and analytical problems.
Course Outcomes: Learners will be able to	
1	Understand basic networking components, commands, protocols, and analyze network traffic using appropriate tools.
2	Design and simulate network topologies and configure routing protocols in a simulated environment.
3	Implement socket-based communication, apply error detection/correction techniques, and configure essential network services.
4	Apply preprocessing, feature selection, and evaluation techniques to build effective ML solutions.
5	Implement and compare ML and DL models using metrics like accuracy, precision, recall, and F1-score
6	Design, train, and optimize deep neural networks and use evolutionary methods to enhance performance.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To study different networking commands and network cables & connectors.	**CO1**
02	Create different network topologies using any network simulator (e.g. Cisco Packet Tracer, GNS3). For each topology perform connectivity tests such as ping, file sharing between devices.	**CO2**
03	Simulate sliding window protocols using any packet tracer tool (any one from Stop and Wait, Go-Back-N, Selective Repeat)	**CO2**
04	Implementation of error detection and correction techniques (any one from CRC, Hamming Code, Checksum) using any programming language.	**CO2**

05	To analyze network traffic using the Wireshark tool. Perform following activities: ● Packet capture and filtering ● Analyze ethernet frames ● IP packet analysis ● ICMP analysis (PING test) ● HTTP/HTTPs request analysis Analyze header of TCP /UDP dump.	**CO3**
06	To configure and verify static routing and dynamic routing protocols (RIP and OSPF) in a simulated network environment using Cisco Packet Tracer.	**CO3**
07	To implement Socket programming using any programming language.	**CO3**
08	To configure the DNS server and to demonstrate the working of the same.	**CO3**
09	Perform data preprocessing by handling missing values, encoding categorical features, applying feature scaling, and splitting datasets.	**CO4**
10	Implement and analyse linear regression and logistic regression models for predictive analysis.	**CO4**
11	Apply Naïve Bayes Classifiers for classification tasks and evaluate model performance.	**CO4**
12	Construct and compare decision tree and random forest models for classification and regression problems.	**CO5**
13	Implement and evaluate clustering techniques such as K-Means, hierarchical clustering, and DBSCAN.	**CO5**
14	Design and train a Neural Network using multi-layer perceptron (mlp) and backpropagation in tensorflow.	**CO6**
15	Develop and analyze Convolutional Neural Networks (CNNs) and apply transfer learning using pre-trained models.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPCL502	**IoT Architecture and Protocols Lab**	-	25	25	-	-	50	

Prerequisite: C programming language, Python programming, Computer Networks.	
Course Objectives: The course aims to	
1	Understand the definition and significance of the Internet of Things.
2	Discuss the architecture, operation, and business benefits of an IoT solution.
3	Examine the potential business opportunities that IoT can uncover.
4	Explore the relationship between IoT, cloud computing, and Data Analytics.
5	Identify how IoT differs from traditional data collection systems.
6	Explore the interconnection and integration of the physical world and be able to design & develop IOT applications.
Course Outcomes: Learners will be able to	
1	Adapt different techniques for data acquisition using various IoT sensors for different applications.
2	Demonstrate the working of actuators based on the collected data.
3	Use different IoT simulators and correlate working of IoT protocols.
4	Adapt different techniques for Integrating IoT services to other third-party Clouds.
5	Execute data analysis and encryption methodologies for deployment of IoT applications.
6	Implement IoT protocols for communication to realize the revolution of internet in mobile devices, cloud and sensor networks.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To study and implement interfacing of different IoT sensors with Raspberry Pi pico/Arduino/NodeMCU.	**CO1**
02	To study and implement interfacing of actuators based on the data collected using IoT sensors. (like led switch ON/OFF, stepper motor etc.)	**CO1, CO2**
03	To study and demonstrate Contiki OS for RPL (like Create 2 border router and 10 REST clients, Access border router from another network (Simulator))	**CO3, CO6**
04	To study and demonstrate working of 6LoWPAN in Contiki OS (simulator)	**CO3, CO6**
05	Write a program on Raspberry Pi/R-Pi pico to push and retrieve the data from cloud like Thingspeak / Thingsboard / AWS / Azure etc.	**CO4, CO6**

06	Study and implementation of cloud based real time data sensing and actuation using google firebase.	**CO1, CO2, CO4**
07	To study and implement IoT Data processing using Pandas.	**CO5**
08	Implementing CoAP Client and Server using Python.	**CO3, CO6**
09	Write a program to create TCP Server on Arduino/Raspberry Pi/ R-Pi pico and respond with humidity data to TCP client when Requested.	**CO1,CO6**
10	Write a program for ESP8266 DHT11/DHT22 Temperature and Humidity Web Server with Arduino IDE.	**CO1,CO6**
11	Write a program to Control Your ESP8266 From Anywhere in the World.	**CO4,CO6**
12	Write a program on NodeMCU / ESP32 / Raspberry Pi pico subscribe to MQTT broker for temperature data and print it.	**CO4,CO6**
13	Write a program for NodeMCU / ESP32 / Raspberry Pi pico / PC Publishing MQTT Messages to ESP8266.	**CO4,CO6**
14	Write a program to collect data from sensor encrypt data send it to receiver (server) and decrypt is at receiving end Arduino/Raspberry Pi pico / Contiki OS/ Any other simulator.	**CO5**
15	To implement cloud based confidential data logging using cryptographic method for IoT applications.	**CO4,CO5**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral Exam (25 Marks)

An Oral exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL5011	**Web-X Lab**	-	25	25	-	-	50	

Prerequisite: Full stack Java	
Course Objectives: The course aims to	
1	Understand the evolution of web technologies and implement static, dynamic, and modern web applications.
2	Develop front-end applications using Angular, routing, data binding, and UI component libraries.
3	Design and implement secure back-end APIs using Node.js, Express, REST, JWT, and OAuth.
4	Integrate databases, cloud services, DevOps practices, and AI solutions for real-world applications.
Course Outcomes: Learners will be able to	
1	Create static and dynamic web pages and implement client-server communication.
2	Build Angular SPAs with routing, lazy loading, and component-based UI development.
3	Develop RESTful APIs with authentication and secure access mechanisms.
4	Perform CRUD operations on SQL/NoSQL databases and execute ETL/OLAP processes.
5	Deploy web applications using Docker, cloud platforms, serverless functions, and IaC tools.
6	Integrate AI APIs, real-time IoT data, and dashboards for practical and industry-oriented solutions.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Perform any TWO Experiment • Implementation of MVC Architecture interaction. • Demonstrate Client–Server communication using Node.js and Express. • Build a simple Progressive Web App (PWA) with manifest and service worker.	**CO1**
02	Perform any TWO Experiment • Set Up an Angular Project using Angular CLI and Data Binding • Implement Routing in Angular (Configure navigation between components using RouterModule). • Develop a Mini Dashboard using Angular + REST API Integration • Integrate Angular Material or Chakra UI Components (Use ready-made UI components for design consistency (buttons, cards, etc.).	**CO2**

	• Develop a Single Page Application (SPA) with Lazy Loading & Routing (Optimize performance and UX with route-based lazy loading).	
3	Perform any TWO Experiment • Implement Asynchronous Programming using Callbacks and Promises • Build a RESTful API using Express.js (Create routes for CRUD operations (GET, POST, PUT, DELETE)). • Implement Authentication using JWT Tokens (Create secure login and verify endpoints using JSON Web Tokens. • OAuth 2.0 Authentication Flow (Demo using Google Login) Demonstrate third-party authentication integration. (Passport.js / Google API)	**CO3**
4	Perform any TWO Experiment • Simple MongoDB CRUD Operations (Create collections, insert documents, update, delete, and query data using MongoDB, Mongo Shell / Compass). • Simple Firebase Realtime Database Setup (Connect a web app to Firebase and perform basic data operations. • ETL Simulation using PostgreSQL / DuckDB (Extract data, transform using SQL queries, and load into another table.	**CO4**
5	Perform any TWO Experiment • Basic Docker Container Setup (Create a Dockerfile, build an image, and run a container for a simple web app). • GitHub Repository Setup & Version Control (Push, pull, and manage branches for a sample project). • Deploy Node.js / Python App on AWS EC2 (Launch EC2 instance, deploy a sample backend app, and access via public IP). • Serverless Function Deployment (Deploy a simple API endpoint using AWS Lambda or Firebase Functions). • Infrastructure as Code (IaC) Simulation (Use Terraform or AWS CloudFormation to provision a basic EC2 instance and S3 bucket). • Monitoring & Logging (Monitor deployed apps using Uptime Robot or Firebase Analytics, analyze logs).	**CO5**
6	Perform any TWO Experiment • Simple Chatbot Integration (Connect a web app to OpenAI API to create a basic chatbot). • Basic Data Visualization (Collect dummy data and plot charts using Chart.js or D3.js). • Recommendation System API (Build a small recommender using Hugging Face or a simple ML model and integrate via REST API. *Tools:* Hugging Face API, Node.js / Python backend). • AI Summarizer Integration (Integrate a text summarization API (Hugging Face/OpenAI) into a web application).	**CO6**

	• Dashboard for Real-Time Data Analytics (Create a web dashboard to visualize live IoT data streams with charts and analytics).	

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL5012	**Computational Theory and Compiler Design Lab**	-	25	25	-	-	50	

Prerequisite: C / C++	
Course Objectives: The course aims to	
1	Familiarize automata, formal languages, and grammar.
2	Model computational problems using FSMs, PDAs, and Turing Machines.
3	Analyze and construct compiler components for lexical and syntax analysis.
4	Apply automata and compiler theory in practical programming tasks.
Course Outcomes: Learners will be able to	
1	Apply automata concepts to design finite state machines for regular languages and pattern recognition.
2	Construct and analyze pushdown automata (PDA) to recognize context-free languages
3	Design Turing Machines for computational and language processing tasks.
4	Integrate automata and compiler theory in practical implementations using modern programming tools.
5	Develop and test intermediate code generation and code optimization strategies
6	Implement lexical and syntax analysis using compiler tools

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Design a Finite State Machine (FSM) that accepts all strings over input symbols {0, 1} having three consecutive 1's as a substring.	**CO1**
02	Design a Finite State Machine (FSM) that accepts all strings over input symbols {0, 1} which are divisible by 3.	**CO1**
03	Design a Finite State Machine (FSM) that accepts all decimal string which are divisible by 3.	**CO1**
04	Design a Push Down Automata (PDA) that accepts all string having equal number of 0's and 1's over input symbol {0, 1} for a language 0^n1^n where n >= 1.	**CO2**
05	Design a Program to create PDA machine that accept the well-formed parenthesis.	**CO2**
06	Design a PDA to accept WCW^R where w is any binary string and W^R is reverse of that string and C is a special symbol.	**CO2**
07	Design a Turing Machine that calculate 2's complement of given binary string.	**CO3**

08	Design a Turing Machine which will increment the given binary number by 1.	**CO3**
09	Design a Turing Machine that's accepts the following language $a^nb^nc^n$ where n>0.	**CO3**
10	Implementation of Lexical Analyzer	**CO4**
11	Implementation of Parser (Any one)	**CO4**
12	Implementation of Intermediate code generation phase of compiler.	**CO5**
13	Implementation of code generation phase of compiler.	**CO5**
14	Study and implement experiments on LEX, YACC.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL5013	Data Analytics and Visualization Lab	-	25	25	-	-	50	

Prerequisite: DBMS, Python programming	
Course Objectives: The course aims to	
1	Introduce fundamental concepts of data exploration, cleaning, and ETLT processes using Python and Jupyter/Colab.
2	Apply KDD, design analytical schemas, simulate OLTP behavior, and perform cloud-based analytics.
3	Apply data mining, association rule learning, and time series forecasting techniques for practical business insights.
4	Enable effective data visualization, interactive dashboards, and cloud BI integration for informed decision-making
Course Outcomes: Learners will be able to	
1	Perform basic data exploration, cleaning, and transformation on structured datasets.
2	Students will analyze data, handle OLTP concurrency, and generate insights from analytical queries.
3	Implement data mining algorithms such as Apriori and FP-Growth for market basket analysis.
4	Conduct time series and sentiment analysis to derive predictive insights.
5	Create static and interactive visualizations using Python, R, Power BI.
6	Build cloud-based and real-time dashboards for business intelligence and AI-driven insights.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Perform any **TWO** practical. • Basic Data Exploration in Jupyter/Colab :Load a CSV (e.g., sales or student dataset) using pandas, check missing values, data types, and basic statistics. • Data Cleaning and ETLT Simulation :Perform missing value handling, outlier detection, and transformation using pandas (fillna, dropna, normalization). • Mini Case Study – Netflix or Spotify Recommendation Insight Analyze sample data to identify popular content by region or genre using EDA. • DataOps Workflow Simulation : Build a small analytics pipeline in Colab integrating Google Sheets → Python Cleaning → CSV Output.	CO1
02	Perform any TWO practical. • Apply a mini KDD process on data extracted from fact and dimension tables. Clean, prepare, and mine the data using techniques like k-means clustering	

	• Deadlock Detection and Handling in OLTP Systems • Implementing a Cloud Data Warehouse in BigQuery: Load a public dataset and perform analytical queries (aggregate sales by region/time). • Designing an IPD (Information Package Diagram) for a Banking System: Model customer, account, and transaction dimensions for analytical reporting.	**CO2**
3	Perform any TWO practical. • Implement Apriori Algorithm Using Python (mlxtend): Find association rules for a small grocery store dataset. • Visualizing Frequent Itemsets and Rules: Plot support vs. confidence and visualize association networks using NetworkX. • Retail Market Basket Analysis: Use transactional data (e.g., from Kaggle) to discover product bundling opportunities. • E-commerce Recommendation Model: Implement FP-Growth and compare results with Apriori for performance and scalability.	**CO3**
4	Perform any TWO practical. • Time Series Decomposition and Visualization:Load monthly temperature/sales data, plot trend, seasonality, and residuals. • Basic Sentiment Analysis: Use TextBlob/VADER to classify movie or product reviews as positive/negative. • Stock Price Forecasting using ARIMA: Analyze daily stock prices, build and evaluate an ARIMA model for prediction. • Twitter Sentiment Analysis Dashboard: Fetch tweets on a trending topic, perform sentiment analysis, and visualize in Power BI or Plotly Dash.	**CO4**
5	Perform any TWO practical. • Visualization with Python (Matplotlib/Seaborn): Create bar, pie, and box plots for a dataset of your choice. • Data Visualization in R: Import CSV, compute summary statistics, and visualize using ggplot2. • Interactive Dashboard in Power BI/Tableau: Build KPIs (sales by region, profit trend) and add interactivity (filters, slicers). • Plotly Dash Mini Web App: Create a small dashboard for visualizing customer churn or IoT sensor data.	**CO5**
6	Perform any TWO practical. • Cloud BI Setup:Connect Power BI to a Google Sheets/BigQuery data source and visualize key metrics. • Building a Real-Time Dashboard using Kafka + Power BI Streaming • Stream live IoT/sensor data into Power BI for instant visualization. • AI-Driven Insights using Power BI Copilot or Tableau GPT Use natural language prompts to generate visuals and insights from a business dataset.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
CEMDML501	Database Management System Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Explore design and develop of relational model 2 3
2	Present SQL and procedural interfaces to SQL comprehensively
3	Introduce the concepts of transactions and transaction processing
4	Design of different queries.
Course Outcomes: Learners will be able to	
1	Design ER /EER diagram and convert to relational model for the real world application.
2	Apply DDL, DML, DCL and TCL commands
3	Apply simple and complex queries
4	Explore PL / SQL Constructs.
5	Learn simple and complex queries
6	Demonstrate the concept of Views, Trigger

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model	1
2	Mapping ER/EER to Relational schema model.	1
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System	2
4	Apply DML Commands for the specified system	2
5	Perform Simple queries, string manipulation operations and aggregate functions.	3
6	Implement various Join operations.	4
7	Perform Nested and Complex queries	5
8	Perform DCL and TCL commands	2
9	Implement procedure and functions	5
10	Implementation of Views and Triggers	6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETMDML501	**Digital Communication & Sensor Technology Lab**	-	25	-	-	-	25	

Prerequisite: Basic Electronics and Electrical Engineering, Discrete mathematics fundamentals	
Course Objectives: The course aims to	
1	To understand the fundamental concepts and components of digital communication systems and various digital modulation techniques.
2	To analyze and implement source coding, channel coding, and line coding techniques for efficient and reliable data transmission.
3	To study and perform signal conversion techniques such as Pulse Code Modulation (PCM) and digital modulation schemes like ASK, PSK, FSK, and QPSK.
4	To understand the working principles, characteristics, and applications of various sensors and transducers used for physical parameter measurement.
Course Outcomes: Learners will be able to	
1	Identify and explain the basic elements, characteristics, and performance parameters of a digital communication system.
2	Demonstrate the process of Pulse Code Modulation (PCM), source coding (Huffman coding), and analyze information rate and entropy of a discrete source.
3	Design and implement error detection and correction codes such as linear block codes, cyclic codes, and convolutional codes.
4	Generate and compare different line coding and digital modulation schemes (ASK, FSK, PSK, QPSK) in terms of performance and bandwidth efficiency.
5	Experimentally analyze the characteristics and working principles of various displacement, pressure.
6	Demonstrate the operation of temperature, and light sensors and MEMS-based microsensors and understand their applications in modern measurement and control systems.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To study and understand the basic elements of a digital communication system	**CO1**
02	To study and perform Pulse Code Modulation (PCM) and Demodulation of an analog signal.	**CO1**
03	To calculate the amount of information and entropy for a given discrete message source.	**CO2**
04	To design and implement Huffman coding for a given discrete source and calculate code efficiency and redundancy.	**CO2**

05	Linear block code generation and error detection	**CO3**
06	Cyclic code generation and error detection	**CO3**
07	Convolutional code generation	**CO3**
08	Line Codes generation and performance comparison	**CO4**
09	Generation (and detection) of Binary ASK, Binary PSK, and Binary FSK.	**CO4**
10	Generation (and detection) of QPSK	**CO4**
11	Study of Characteristics of a Potentiometer as a Displacement Sensor	**CO5**
12	Study of LVDT (Linear Variable Differential Transformer) Characteristics	**CO5**
13	Study of Capacitive Transducer for Displacement or Pressure Measurement	**CO5**
14	Study and Characterization of a Thermistor (Temperature Sensor)	**CO6**
15	Study of Photo-resistive Sensor (LDR) characteristics (Light intensity vs resistance)	**CO6**
16	Demonstration of MEMS-based sensors (e.g., accelerometer, pressure sensor using Arduino or NI-ELVIS)	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ARMDML501	**Mechatronics Lab**	-	25	-	-	-	25	

Prerequisite: Basic knowledge of electrical and mechanical systems, control theory, and microcontroller programming	
Course Objectives: The course aims to	
1	Understand fundamentals of mechatronic systems, sensors, and actuators.
2	Interface and control electrical and mechanical devices using microcontrollers
3	Identify and analyze dynamic characteristics of actuators.
4	Apply automated controls using pneumatic and pneumatic. systems.
Course Outcomes: Learners will be able to	
1	Demonstrate the interfacing and control of sensors and actuators using microcontrollers.
2	Demonstrate the interfacing of different electrical/mechanical devices (motors, heaters, etc.) with microcontrollers.
3	Identify dynamic characteristics of an actuator through experimental system identification.
4	Demonstrate use of automated controls using pneumatic systems.
5	Demonstrate use of automated controls using hydraulic systems.
6	Implement a program on the PLC system and demonstrate its application.

Suggested List of Experiments

Sr. No.	List of Experiments:	CO Mapping
1	Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table (It is suggested to program to vary the position of the rotary or XY table and compare the positioning accuracy using a standard calibrated angular or linear sensor).	**CO1**
2	Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup (It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics).	**CO2**
3	System Identification of any one of the actuators.	**CO3**
4	Designing a sequential operation for two cylinders using electro-pneumatic circuits.	**CO4**
5	Simulation of basic pneumatic and electro-pneumatic circuits (using software like Festo, AutoSim , etc.).	**CO4**
6	Simulation of hydraulic and electro-hydraulic circuits (using software like Festo, AutoSim, etc).	**CO5**

7	Designing a sequential operation for two cylinders using electro-hydraulic circuits. a) Designing sequential operation for two cylinders using electro-hydraulic circuits. or b) Designing sequential operation for two cylinders using electro- pneumatic circuits.	**CO5**
8	Experiments on Ladder programming on PLC for simple on-off control, timers, counters, two motor system, and simple control applications with logic/ timers/counters.	**CO6**
9	Experiments on Ladder programming for Mechatronics systems (e.g. bottle filling plant, control of electro-pneumatic or electro-hydraulic systems).	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ITMDML501	Sensors, Actuators and Transducers Lab	-	25	-	-	-	25	

Prerequisite:	
Course Objectives: The course aims to	
1	Implement, test and characterize sensors (analog/digital/MEMS) used in IoT.
2	Design simple signal-conditioning circuits and ADC interfacing.
3	Control actuators (DC/stepper/servo/relay/solenoid) from microcontrollers.
4	Calibrate sensors, perform error analysis and document results.
Course Outcomes: Learners will be able to	
1	Implement, test and characterize sensors (analog/digital/MEMS) used in IoT.
2	Implement, test and characterize transducers used in IoT.
3	Implement, test and characterize micro sensors used in IoT.
4	Implement, test and characterize actuators (DC/ stepper/servo/relay/solenoid) used in IoT.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of analog and digital temperature sensors	CO1
02	Interfacing MEMS accelerometer (MPU6050) with Arduino	CO2
03	Interfacing servo and stepper motors using PWM	CO4
04	Interfacing DC motor with H-bridge driver circuit	CO4
05	Study of piezoelectric transducer	CO2
06	Signal conditioning for sensor data (amplifier + filter)	CO3
07	IoT data acquisition using ESP32/ESP8266 and cloud platform	CO3
08	Calibration and performance evaluation	CO2,3,4
09	Mini project using sensors and actuators	CO1,2,3,4
10	Measurement of temperature using DHT11, thermistor, thermocouple, LM35	CO2,
11	Measurement of pressure using Piezoelectric sensor, Bourdon tube, Strain-gauge pressure sensor, BMP180, MPX5010	CO2
12	Demonstration of IR sensor for proximity sensing	CO3
13	Automatic lighting system using LDR	CO3
14	Motion detection using MEMS Accelerometer (ADXL335, MPU6050), Gyroscope	CO3,4

Reference Websites

- https://www.arduino.cc
- https://randomnerdtutorials.com
- https://thingspeak.com
- https://blynk.io
- https://www.mems-exchange.org

Lab performance: Minimum 8 experiments must be conducted to keep the term valid. Any other experiment may be conducted on the related topics of the theory course.

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
MEMDML501	**Renewable Energy Sources Lab**	-	25	-	-	-	25	

Prerequisite: Thermal Engineering	
Course Objectives: The course aims to	
1	To study working principles of various renewable energy sources and their utilities
2	To study working principles of various Thermal & Hydro Electric Power plants.
3	To study economics of harnessing energy from renewable energy sources
Course Outcomes: Learners will be able to	
1	Analyze the various energy sources & its availability in India & world.
2	Describe the operating principle of Thermal & hydel power plants.
3	Describe the operating principle of nuclear power plants.
4	Analyze different solar collectors using geometrical parameters and photovoltaics for generation of solar energy & its application
5	Identify and analyze various wind turbine energy harnessing techniques.
6	Identify various Mini & Micro Hydro Electric Plants & wind turbine energy harnessing techniques

Suggested List of Experiments (Any Five from Following List.)

Sr. No.	List of Experiments	CO Mapping
01	Demonstration on Solar Cooker	4
02	Demonstration on Solar Panel Test Rig.	4
03	Case Study on Wind Mill.	5
04	Study of Components of Wind Mill.	5
05	Study of Components & layout of thermal power plants.	2
06	Study of Component & layout of hydroelectric power plant.	2
07	Study of Mini & Micro Hydro Electric Plants	6
08	A case study on Energy Scenario & pattern of consumption of fossil fuel in Indian scenario.	1

09	Study of Components & layout of nuclear power plants.	3
10	Compulsory Visit to Any Renewable Source installation or conventional power plant.	1-6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
EEMDML501	**Special Machines and smart grid Lab**	-	25	-	-	-	25	

Prerequisite: Students know the construction, working principle and operation of DC machines, transformers and Induction motors	
Course Objectives: The course aims to	
1	Introduce various special electrical machines beyond conventional DC and AC machines.
2	Explain the construction, working principles, and control techniques of stepper, reluctance, and permanent magnet motors.
3	Highlight applications of special motors in industrial automation, robotics, and electric vehicles.
4	Explore various control implementation incorporated in smartgrid in simulation or with hardware.
Course Outcomes: Learners will be able to	
1	Exemplify the working of Stepper motor and its control.
2	Demonstrate the functioning of SRM motor and its control
3	Illustrate the working of BLDC motor and its control
4	Illustrate the operational features of PMSM motor and its control
5	Identify and study the various smart grid components.
6	Understand the modelling of renewable resources such as PV, Wind, and fuel cell.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of Smart Grid components.	CO5
02	Simulation on Modelling of PV system using MATLAB.	CO6
03	Simulation on Modelling of DFIG based wind power system.	CO6
04	Simulation of Grid connected PV MPPT single stage. CO1	CO6
05	To measure and analyze the power quality parameters with and without compensation. (voltage, THD, pf and current)	CO5
06	Simulation/Emulation of DC Microgrid with steady state/transient performance analysis	CO5
07	Simulation/ Emulation of AC Microgrid with steady state/transient performance analysis.	CO5

08	Study of solar PV charateristics	CO6
09	Study of constructional features and working principle of different special motors (Stepper, SRM, BLDC, PMSM, LIM).	CO1 to CO4
10	Speed control of a Stepper Motor using Arduino or Microcontroller Interface.	CO1
11	Determination of Step Angle and Resolution of Stepper Motor.	CO1
12	Characteristics of Switched Reluctance Motor (SRM).	CO2
13	Speed control of SRM using a power converter.	CO2
14	Study of Permanent Magnet Synchronous Motor (PMSM).	CO4
15	Experimental setup of PMSM drive using inverter and controller.	CO4
16	Study of BLDC motor and its characteristics.	CO3
17	Integration of special motor with sensor and control module for application (e.g., robotic arm / conveyor).	CO3

Virtual Lab Website Reference:

1. **http://vlab.co.in/broad-area-electrical-engineering**
2. **https://www.vlab.co.in/broad-area-mechanical-engineering - Energy Storage Labs, Solar Energy lab, Wind Energy Lab**

Virtual Lab Website Reference:

1. **http://vlab.co.in/broad-area-electrical-engineering**

Term Work: Minimum 8 experiment/simulation must be done for satisfactory completion of the term.

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Department of Computer Science and Engineering
(IoT & Cyber Security Including Blockchain Technology)

Third Year Engineering Curriculum: Semester VI

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPCC601	Blockchain Technology	20	20	60	1	2	100	

Prerequisite: Web Development Basics, Networking Basics, Cryptography Fundamentals	
Course Objectives: The course aims to	
1	Understand the core principles of Distributed Ledger Technologies (DLTs) and Blockchain architecture, including their structure, functionality, and real-world applications.
2	Explain and evaluate consensus mechanisms and mining processes by analysing the operation of the Bitcoin network.
3	Develop and deploy smart contracts on the Ethereum platform and explore their role in decentralized application development.
4	Examine Hyperledger Fabric architecture and analyse blockchain integration with emerging technologies, crypto assets, and tokens.
Course Outcomes: Learners will be able to	
1	Explain the principles, architecture, and functioning of Distributed Ledger Technologies (DLTs) and Blockchain systems
2	Analyse the working of the Bitcoin network, including mining, consensus mechanisms, transaction validation, and network operations.
3	Understand Ethereum architecture , transactions, and smart contracts, and develop and deploy smart contract applications.
4	Understand the framework, tools, architecture, components, and consensus mechanisms of Hyperledger Fabric and design a basic blockchain network.
5	Evaluate different categories of crypto assets and tokens in terms of functionality and application.
6	Assess the role of blockchain in enhancing emerging technologies.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to DLT and Blockchain** Overview of Distributed Ledger Technologies (DLTs), Types of Blockchains, Blockchain origin, components, phases, Block structure, Header, Hash, Block Height, Genesis Block, Chaining Blocks, Merkle Tree, Decentralized Consensus, Byzantine General's Problem. **Self Learning Topic:** Blockchain Demo	06	CO1

02	**Bitcoin** What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, validation of transactions, PoW, Bitcoin Network: Peer- to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks **Self-Learning Topic:** Difficulty adjustment & 51% attack, compare different consensus algorithms like PoA, pBFT	**09**	**CO2**
03	**Ethereum** Components, Architecture of Ethereum, Miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, Accounts, Patricia Merkle Tree, Swarm, Whisper and IPFS, Ethash, Pos consensus, End to end transaction in Ethereum. Smart Contracts: Smart Contract programming using solidity, Metamask (Ethereum Wallet), Setting up development environment, Use cases of Smart Contract, Opportunities and Risk. Smart Contract Deployment: Introduction to Truffle, Use of Remix and test networks for deployment	**09**	**CO3**
04	**Hyperledger Fabric** Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain. Components: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT, PAXOS Designing Hyperledger Blockchain **Self-Learning Topic:** Fundamentals of Hyperledger Composer	**08**	**CO4**
05	**Cryptoassets** Definition and Characteristics of Cryptoassets. Importance and Role of Cryptoassets in Blockchain Ecosystem ERC-20 Tokens: Key Functions and Events, Creating and Deploying ERC-20 Tokens, Use Cases. ERC721 Tokens: Key Functions, Real-World Applications, ERC-20 vs ERC-721 Fundraising Mechanisms: ICO, STO Different crypto currencies	**05**	**CO5**
06	**Blockchain and Emerging Technologies** Blockchain with AI, IoT, Cloud, and ML **Self-Learning Topic:** Case studies**.**	**05**	**CO6**

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr.Gavin Wood, O'reilly.

3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
5. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
6. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.

References:

1. Mastering Blockchain, Imran Bashir, Packt Publishing
2. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
3. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley.
4. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them, Antony Lewis.for Ethereum and Blockchain, Ritesh Modi, Packt publication.
5. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
6. NPTEL: https://onlinecourses.nptel.ac.in/noc22_cs44/preview?utm_source
7. NPTEL: https://nptel.ac.in/courses/106104220?utm_source

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPCC602	Cryptography and Network Security	20	20	60	1	2	100	

Prerequisite: Computer Networks, Concepts of Number Theory	
Course Objectives: The course aims to	
1	Understand the fundamentals of cryptographic algorithms and network security concept.
2	Apply symmetric and asymmetric encryption techniques key algorithms to secure communication.
3	Analyze various authentication, integrity, and key management mechanisms.
4	Evaluate different network security protocols, attacks on networks, use of firewall and IDS.
Course Outcomes: Learners will be able to	
1	Understand basics security concepts of Cryptography and Network Security and classical cryptography methods.
2	Apply symmetric encryption techniques and modes of operations for data protection.
3	Apply asymmetric encryption techniques and digital signatures for data protection.
4	Demonstrate various key management and authentication techniques.
5	Understand various protocols for network security to protect against the threats in the network
6	Analyze and mitigate attacks on network and infer the use of IDS and firewall.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Cryptography and Network Security** Fundamental goals of computer security, Computer security policies, and attacks, the OSI security architecture, Network security model, Classical Encryption techniques: mono-alphabetic and poly-alphabetic, substitution techniques: Vigenère cipher, Playfair cipher, transposition techniques. **Self Learning Topic:** Study some more classical encryption techniques and solve more problems on all techniques.	06	CO1
02	**Symmetric Key Cryptography** Principles of symmetric encryption, Block ciphers and stream ciphers DES, Triple DES, AES algorithms, Modes of operation: ECB, CBC, CFB, OFB, CTR, Case study: Securing IoT data transmission using AES.	08	CO2
03	**Asymmetric Key Cryptography** Public key cryptography principles, RSA algorithm, Diffie-Hellman key exchange, ECC (Elliptic Curve Cryptography) and its applications in IoT Digital signatures, Hash functions (MD5, SHA family).	08	CO3

04	**Key Management, Authentication & Integrity Mechanisms** Key distribution and exchange protocols, Digital certificates, and PKI, Authentication protocols: Challenge-response, Kerberos, and X.509, Message Authentication Codes (MAC), HMAC, CMAC, Cryptographic Integrity checking in IoT devices.	**07**	**CO4**
05	**Network Security and Protocols** Secure Socket Layer (SSL) / Transport Layer Security (TLS), IP Security: Architecture, Protection Mechanism (AH and ESP), Role of Network Security in Integrity, combining security associations, HTTPS, SSH, Email security: PGP, S/MIME and Wireless Network security.	**08**	**CO5**
06	**Cyber Attacks and IoT Security Applications** DDoS, Man-in-the-middle, Replay, Phishing, Ransomware, Zero Trust in network Security. System Security: Intruders, Intrusion Detection, Firewall - Types, Location and Configurations. **Self-learning Topic:** Study the recent malicious software and their effects.	**05**	**CO6**

Text Books:

1. William Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson Education, March 2013.
2. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw Hill.
3. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

References:

1. Kaufman, Charlie, Perlman, Radia, & Speciner, Mike. (2002). Network Security: Private Communication in a Public World (2nd ed.). Pearson / Prentice Hall.
2. Dr. Debdeep Mukhopadhyay IIT Kharagpur: http://nptel.ac.in/courses/106105031/lecture

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6011	**AI with Robotics**	20	20	60	1	2	100	

Prerequisite: Machine Learning, IoTAP	
Course Objectives: The course aims to	
1	Understand the robot physical systems; kinematics for given robot structures and motion planning basics.
2	Integrate visual input into robot perception; understand sensor fusion for better environment understanding trajectory planning & control in robotic/IoT contexts.
3	Provide foundational understanding of Artificial Intelligence, intelligent agents, and problem-solving methodologies for real-world applications.
4	Develop skills in search algorithms, knowledge representation, and machine learning techniques for designing intelligent and adaptive systems.
Course Outcomes: Learners will be able to	
1	Analyse sensors, actuators and understand physical systems, kinematics of Robotics.
2	Apply computer vision, planning & control in robotic/IoT contexts.
3	Implement motion planning, control and reinforcement learning for mobile/robotic platforms.
4	Explain the core concepts, history, and structure of AI systems, including the role of intelligent agents and rational decision-making.
5	Apply uninformed, informed, and optimization-based search algorithms along with logical reasoning techniques to solve AI problems.
6	Analyze and implement learning, planning, and natural language processing techniques for developing intelligent real-world applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction & Foundations of Robotics Systems** Robot components: sensors, actuators, effectors Kinematics: forward & inverse, Denavit-Hartenberg representation Dynamics basics & Motion planning, fundamentals Workspace & reachability, robot types: manipulators, mobile, aerial, legged.	**08**	**CO1**
02	**Computer Vision & Perception for Robotics** Introduction to computer vision for robotics Image formation, camera models, calibration Feature detection & matching Object detection / segmentation	**07**	**CO2**

	Depth perception / stereo vision Visual tracking & sensor fusion (vision + others)		
03	**Control Systems and Motion Planning in Robotics**	**07**	**CO3**
	Differential motion, Jacobians Manipulator dynamics Control principles: PID, feedback control Trajectory planning & path planning Mobile robot control (non-holonomic)		
	Self-Learning Topic: Trends: IoT/edge robotics, cloud robotics		
04	**Introduction to Artificial Intelligence & Intelligent Agents**	**07**	**CO4**
	Introduction and History of AI, Components and Foundations of AI, Categorization and Sub-areas of Intelligent Systems, Applications and Current Trends in AI, Agents and Environments, Types of Agents, Learning Agent, The Concept of Rationality, Problem Solving by Searching: Problem Solving Agent, Formulating Problems, Example Problems		
05	**Search Techniques and Knowledge Representation**	**07**	**CO5**
	Uninformed Search: BFS, DFS, Depth-Limited Search, DFID, Informed Search: Greedy Best-First Search, A* Search, Local Search & Optimization: Hill Climbing, Simulated Annealing, Genetic Algorithms, Adversarial Search: Game Playing, Min-Max Search, Alpha-Beta Pruning, Knowledge-based Agents and Knowledge Representation: Overview of Propositional & First Order Logic (Syntax, Semantics, Inference, Forward & Backward Chaining)		
06	**Learning, Planning & AI Applications**	**06**	**CO6**
	Planning Problem: State-space Search, Partial-order & Hierarchical Planning. Learning: Forms of Learning, PAC Learning, Basics of Statistical and Reinforcement Learning (Passive & Active), Introduction to NLP: Language Models, Grammars, Parsing, Real-world AI Applications: Healthcare, Retail, Banking		
	Self-Learning Topic: Computer Vision and Image Recognition, Ethical Hacking and AI Security, Edge AI and IoT Integration		

Text Books:

1. Robert J. Schilling, “Fundamentals of Robotics: Analysis and Control Prentice Hall, Inc. 1st Edition (1990).
2. S. B. Nikku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., 2020.
3. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach”, Fourth Edition Pearson Education, 2020.
4. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning, First edition, 2011

5. George F Luger, “Artificial Intelligence” Low Price Edition, Fourth edition, Pearson Education.,2005

References

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005.
2. Computer Vision: Algorithms and Applications by Richard Szeliski, Springer Science & Business Media 2nd Edition (2022).
3. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.\
4. Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication.
5. https://onlinecourses.nptel.ac.in/noc19_cs47/preview
6. https://onlinecourses.nptel.ac.in/noc25_cs118/preview
7. https://onlinecourses.nptel.ac.in/noc25_cs149/preview
8. https://onlinecourses.nptel.ac.in/noc25_cs91/preview
9. https://onlinecourses.nptel.ac.in/noc25_cs92/preview
10. https://onlinecourses.nptel.ac.in/noc25_cs106/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6012	Application Security and Secure Coding Principles	20	20	60	1	2	100	

Prerequisite: Operating Sytstem, Computer Network Fundamentals	
Course Objectives: The course aims to	
1	Understand the fundamental concepts of application and software security.
2	Identify, analyze, and mitigate common web and API vulnerabilities.
3	Apply secure coding principles to prevent security flaws.
4	Evaluate and enhance software security using static and dynamic testing methods.
Course Outcomes: Learners will be able to	
1	Explain key concepts of application security and threat modeling.
2	Demonstrate secure coding techniques and input validation practices.
3	Analyze and mitigate web application vulnerabilities.
4	Apply secure design principles in APIs, microservices, and cloud apps.
5	Perform application security testing using SAST, DAST, and related tools.
6	Integrate security practices within DevSecOps and containerized environments.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamentals of Application Security**	07	CO1
	Introduction to Application Security, CIA Triad and STRIDE Threat Modeling OWASP Top 10 (2021/2025) Overview, Secure Development Lifecycle (SDLC), Maturity models (Capability Maturity Model (CMM), Software Assurance Maturity Model (SAMM)) Security weaknesses and vulnerabilities at the source-code level, Application Attack Surface & Risk Management, Security Policies and Compliance (ISO 27034, NIST 800-64)		
	Self-learning Topics: Case Study: Real-world Application Breaches		
02	**Secure Coding Principles**	08	CO2
	SQL Injection and XSS Attacks, Cross-Site Request Forgery (CSRF), Insecure Direct Object References (IDOR), Security Misconfigurations, Broken Authentication and Session Hijacking, Spyware, Adware, and Malvertising, Integration with OS Security and Network Access Controls		

03	**Email Communication & Mobile Device Security** Understanding Email Security Concepts, Email Security Procedures, Knowing Mobile Device Security Concepts, Mobile Security Procedures, Understanding How to Secure iPhone, iPad, Android, and Windows Devices **Self-learning Topics:** Web Browser Security Settings, Social Network Security Settings.	**06**	**CO3**
04	**Secure APIs, Mobile, and Cloud Applications** REST, SOAP and GraphQL API Security (OAuth2, JWT), Rate Limiting and Input Validation in APIs Mobile Application Security: iOS and Android Embedded and IoT Application Security Basics, Cloud Security Concepts, Shared Responsibility Model, Cloud Threats and Privacy Issues **Self-learning Topics:** Mobile Device Hardening	**08**	**CO4**
05	**Application Security Testing** Introduction to Application Security Testing, Static Application Security Testing (SAST), Dynamic Application Security Testing (DAST). Interactive Application Security Testing (IAST), Runtime Application Self-Protection (RASP), Mobile Application Security Testing (MAST), Fuzz Testing and Vulnerability Verification	**06**	**CO5**
06	**Advanced Secure Development and DevSecOps** Overview of DevSecOps Practices, Security in CI/CD Pipelines, Container and Kubernetes Security, Supply Chain Attacks and Software Bill of Materials (SBOM), Secure Deployment, Patch, and Update Management, Incident Response and Application Logging	**07**	**CO6**

Text Books:

1. Alice and Bob Learn Application Security – Tanya Janca (Wiley, 2020)
2. Foundations of Information Security – Jason Andress (No Starch Press, 2021)
3. Web Application Security: Exploitation and Countermeasures for Modern Web Applications – Andrew Hoffman (O'Reilly, 2020)
4. Cloud Security and Privacy – Tim Mather, Subra Kumaraswamy, Shahed Latif (O'Reilly)

References:

1. OWASP Secure Coding Practices Guide (Free PDF – OWASP.org)
2. The Web Application Hacker's Handbook – Dafydd Stuttard & Marcus Pinto (Wiley, 2nd Ed.)
3. Secure Coding in C and C++ – Robert C. Seacord (Addison-Wesley, 3rd Edition)
4. API Security in Action – Neil Madden (Manning, 2020)
5. https://nptel.ac.in/courses/106106199?utm_source
6. https://onlinecourses.nptel.ac.in/noc23_cs32/preview?utm_source

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)
Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)
End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6013	Software Engineering	20	20	60	1	2	100	

Prerequisite: Object Oriented Programming with Java, Python Programming.	
Course Objectives: The course aims to	
1	Introduce major software process models and their applicability.
2	Familiarize students with requirement gathering and analysis modeling.
3	Provide understanding of fundamental design concepts in software projects.
4	Develop competence in software sizing and cost estimation techniques.
5	Build knowledge of risk handling, scheduling, and configuration management.
6	Build skills in software testing and quality assurance practices
Course Outcomes: Learners will be able to	
1	Understand major software process models and when to use them.
2	Identify requirements and develop basic analysis models.
3	Understand the designing concepts for software projects.
4	Apply size metrics and models to estimate effort/cost of software.
5	Identify risks, schedule tasks, and manage configuration to maintain quality.
6	Design basic tests and apply QA checks to support software reliability.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction To Software Engineering and Process Models** Software Engineering process framework, Prescriptive Process Model - Waterfall Model, Incremental Process Model - RAD Model, Evolutionary Process Models - Prototyping model, Spiral model Agile Process Model - Extreme Programming, Adaptive Software Development (ASD), Scrum, Dynamic System Development Method (DSDM), CRYSTAL. Agile Unified Process (AUP).	8	CO1
02	**Software Requirements Analysis and Modeling** Requirement Engineering - Requirement Gathering and Analysis, Types: Functional, Product, organizational, External Requirements, Eliciting Requirements, Developing Use-cases, Building requirement models, Negotiation, Validation. Software Requirement Specification (SRS) - Need, Format, and its Characteristics. Translating Requirement model – Analysis models (Use-Case Diagram, Activity Diagram, Data Flow Diagram, Entity Relationship Diagram), Design models (Class Diagrams, Sequence Diagrams)	7	CO2

03	**Software Design** Design Principles, Fundamental Design Concepts (Abstraction, Information hiding, Structure, Modularity, Concurrency, Verification, Aesthetics), Effective Modular Design, Cohesion and Coupling, Architectural design. **Self-Learning Topic:** Design notations: Structured Flowcharts, Decision Tables.	**6**	**CO3**
04	**Software Project Cost Estimation** Metrics for Size Estimation: Line of Code (LoC), Function Points (FP). Project Cost Estimation Approaches - Overview of Heuristic, Analytical, and Empirical Estimation. COCOMO II (Constructive Cost Model-II).	**5**	**CO4**
05	**Software Project Planning & Management** The Management Spectrum - 4P's. Project Scheduling - Basic principles, Work breakdown structure, Activity network, Scheduling techniques - Critical Path Method (CPM), Program Evaluation Review Technique (PERT). Project Tracking - Timeline charts, Earned Value Analysis, Gantt Charts. Risk Analysis and Management - Risk identification, Risk assessment, Risk management and monitoring, Risk Refinement and Mitigation, RMMM Plan. Software Configuration Management (SCM), Version Control and Change Control. **Self-Learning Topic**: Git branching model and a simple change-control template.	**8**	**CO5**
06	**Software Testing and Quality Assurance** Software Testing Strategies - Unit testing, Integration testing, Validation testing, System testing. Testing Techniques - White-box testing: Basis path, Control structure testing, Black-box testing: Graph based, Equivalence, Boundary Value Analysis. Software Quality Management vs. Software Quality Assurance, Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability. Quality Evaluation standards - Six Sigma, CMMI- Levels, Process areas. Advanced Trends in Software Engineering (Key Practices of Software Engineering-ML, AI, DevOps, IoT, Blockchain)	**8**	**CO6**

Text Books:

1. Roger Pressman, "Software Engineering: A Practitioner's Approach", 9th edition , McGraw-Hill Publications, 2019
2. Ian Sommerville, "Software Engineering", 9th edition, Pearson Education, 2011
3. Rajib Mall, "Fundamentals of Software Engineering", 5th edition, Prentice Hall India, 2014
4. Deepak Jain – Software Engineering: Principles and Practices, OUP, 2008.

Reference Books:

1. Ali Behfrooz and Fredeick J. Hudson, "Software Engineering Fundamentals", Oxford University Press, 1997
2. Srinivasan Desikan & Gopalaswamy Ramesh – Software Testing: Principles and Practices, Pearson, 2007

3. Pankaj Jalote, "An integrated approach to Software Engineering", 3rd edition, Springer, 2005
4. Jibitesh Mishra and Ashok Mohanty, “Software Engineering”, Pearson , 2011
5. Ugrasen Suman, “Software Engineering – Concepts and Practices”, Cengage Learning, 2013
6. Waman S Jawadekar, “Software Engineering principles and practice”, McGraw Hill Education, 2004
7. Ron Patton – Software Testing, 2nd Ed., Sams, 2005
8. Grady Booch, James Rambaugh, Ivar Jacobson, “The unified modeling language user guide”, 2nd edition, Pearson Education, 2005

Online References:

1. https://nptel.ac.in/courses/106/105/106105182/
2. https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3. https://www.mooc-list.com/course/software-engineering-introduction-edx
4. https://www.sei.cmu.edu/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6021	IoT for Smart Systems	20	20	60	1	2	100	

Prerequisite: IoT Architecture and Protocols, Computer Networks.	
Course Objectives: The course aims to	
1	Understand how IoT parts work together to deliver smart services.
2	Learn to build a basic data flow and use simple analytics with clear KPIs.
3	Know when to use common IoT protocols/standards and the basics of device onboarding and identity.
4	Learn how IoT platforms and smart-home ecosystems are put together, with basic security.
5	Understand the Digital Twin idea and how it helps monitor and improve real systems.
6	Understand the basics of IoRT (robots + IoT) and its key safety/ethics points.
Course Outcomes: Learners will be able to	
1	Identify IoT parts for a smart use case and link them to a few measurable KPIs.
2	Understand a simple edge–fog–cloud pipeline and pick suitable analytics and KPIs for a scenario.
3	Select an appropriate protocol/standard and outline a simple onboarding & identity plan.
4	Identify a platform design with edge choices and basic security/privacy.
5	Learn Digital Twin plan with model type, KPIs, and how data will sync and be monitored.
6	Evaluate an IoRT example and recommend connectivity, a fail-safe step, and one safety/privacy mitigation.

Module	Detailed Contents	Hrs.	CO Mapping
01	**IoT Subsystems & Smart Services** IoT Subsystems: Sensing, actuation, communication, computation, service layer attributes: Dependability, Interoperability, Security, Maintainability. Smart Services & Domains: Smart home, smart healthcare, smart city, smart energy, value chains, and stakeholders. System thinking for smart systems: Requirement scoping, KPIs, constraints (power, latency, cost).	6	CO1
02	**IoT Data Analytics & Visualization** Data pipeline: edge → fog → cloud (Where to place filtering/feature extraction/inference; latency/throughput/cost trade-offs); Ingestion, TSDB storage, batch/stream/real-time processing. Analytics in smart systems: Anomaly detection, prediction, recommendation (concepts → examples: energy, mobility, healthcare). Dashboards & Visualization: Dashboards, KPIs, alerting (Power BI/Tableau/Python)	8	CO2

03	**Linear & Non-linear Programming Problems** Application protocols in context (MQTT, CoAP, AMQP, DDS): choose by constraints (power, QoS, reliability). Interoperability frameworks & standards: OneM2M, OCF/AllJoyn basics, IEEE P2413 viewpoints. Introduction to Thread & Matter (consumer IoT stacks): Motivation, role in smart-home/smart-building ecosystems, basic commissioning, and routines. Device onboarding & identity (high level): Provisioning, access control, data sharing across ecosystems. **Self-Learning Topic:** Cellular/LPWAN choices (LTE-M/NB-IoT/LoRa) for smart-city deployments (high-level comparison).	**7**	**CO3**
04	**Smart IoT Platforms & Ecosystems** Cloud IoT platform architecture: Device registry, device shadow/twin, rules engine, messaging, TSDB, OTA updates, fleet management. Consumer ecosystems (conceptual): Hubs/scenes/routines; data flows in Apple HomeKit, Google Home, Amazon Alexa. Edge patterns: Local filtering/inference, gateway bridging, cloud-fallback. Security & privacy in platforms: Device identity, credentials/keys, tokens & scopes, least privilege, data retention.	**9**	**CO4**
05	**Digital Twin for Smart Systems** Concepts & lifecycle: Modelling, synchronization, monitoring, analytics/optimization loops, Applications: Smart buildings (energy), mobility, healthcare assets; benefits & limitations. Implementation view (conceptual): Data sources, model types (data-driven vs physics-informed), KPIs. Case-study: Smart grid & EV charging, smart city ops (traffic/waste), smart agriculture. **Self-Learning Topic:** Platforms/standards (e.g., Azure Digital Twins, Eclipse Ditto, OPC UA integration).	**8**	**CO5**
06	**Internet of Robotic Things (IoRT)** IoRT Concepts & Architecture, IoRT Applications: Drones for surveillance/inspection, Warehouse AGVs (Automated Guided Vehicles). Systems View for Smart Services, Security & Ethics (brief overview): Safety-of-operation, Privacy-by-design, minimal data retention (vision/audio), Simple threat sketch.	**4**	**CO6**

Text Books:

1. Bahga, A. & Madisetti, V. Internet of Things: A Hands-On Approach. Universities Press/VPT.
2. Raj, P. & Raman, A. Internet of Things: Enabling Technologies, Platforms, and Use Cases. CRC Press.
3. Cirani, S. et al. Internet of Things: Architectures, Protocols and Standards. Wiley.
4. Greengard, S. The Internet of Things. MIT Press.

References:

1. https://csrc.nist.gov/pubs/ir/8259/a/final
2. https://owasp.org/www-project-internet-of-things/
3. https://csa-iot.org/all-solutions/matter/
4. https://www.threadgroup.org/
5. https://learn.microsoft.com/azure/digital-twins/
6. https://www.eclipse.org/ditto/
7. https://docs.ros.org/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6022	Ethical Hacking and Digital Forensic	20	20	60	1	2	100	

Prerequisite: Computer Networks, Computer Hardware, System Security, Operating Systems.	
Course Objectives: The course aims to	
1	Understand ethical hacking and different phases of an attack.
2	Learn penetration-testing, tool usage, and social-engineering vectors.
3	Understand concepts and workflow of digital forensics and incident response.
4	Learn forensic duplication and acquisition methods.
5	Develop understanding of forensic investigation/analysis.
6	Learn proper evidence handling and produce clear, defensible forensic reports.
Course Outcomes: Learners will be able to	
1	Describe the concept of ethical hacking and explore different phases in ethical hacking.
2	Explain penetration-testing phases and system hacking tools with key social-engineering techniques.
3	Understand digital forensics concepts and the incident-response workflow.
4	Learn various Digital Forensic techniques to acquire a forensically sound copy of evidence.
5	Analyse forensic evidence for investigation on Windows/Linux systems.
6	Compile a detailed Forensic report using proper evidence handling with chain of custody.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Ethical Hacking** Introduction to Ethical Hacking - Scope, Legality, Professional ethics, Hacker hats (white/black/grey) and red/blue/purple roles. Attacker lifecycle, Footprinting (Reconnaissance) with tools, scanning with tools, Enumeration with tool, Vulnerability landscape (injection, misconfiguration, weak auth). **Self-learning Topics**: OWASP top 10 Attacks	7	CO1
02	**Penetration Testing and Social Engineering** System hacking, hacking tools. Penetration testing - Phases of penetration testing, Deliverables: scope control, evidence management. Social Engineering - Phishing, Vishing, Smishing, Baiting, USB drop. Defensive Controls - Awareness training, DMARC/SPF/DKIM, reporting pipelines.	6	CO2

03	**Digital Forensics and Incident Response** Introduction to Digital Forensics and Digital Evidence, The Need for Digital Forensics, Types of Digital Forensics, Digital Forensics Life Cycle. Incident and Initial Response: Introduction to Computer Security Incident, Goals of Incident response, Incident Response Methodology, Initial Response, Formulating Response Strategy.	**7**	**CO3**
04	**Forensic Duplication and Acquisition** Forensic Duplication - Imaging concepts, hash integrity, Types of Forensic Duplicates, Introduction to Forensic Duplication Tools (dd/FTK/Autopsy). Data Acquisition - Introduction to Static and Live/Volatile Data, Static Data Acquisition from Windows (FTK Imager), Static Data Acquisition from Linux (dd/dcfldd), Live Data Acquisition from Windows (FTK Imager). Network Forensics (wireshark).	**8**	**CO4**
05	**Forensic Investigation and Analysis** Forensic Investigation - Investigating Registry Files, Investigating Log Files, Data Carving (Bulk Extractor). Forensic Analysis - Introduction to Forensic Analysis, Live Forensic Analysis, Forensic Analysis of acquired data in Linux, Forensic Analysis of acquired data in Windows. Mobile Forensics, Email forensics - Process, challenges, and components. **Self-Learning Topic:** Case studies for mobile and email forensic.	**8**	**CO5**
06	**Evidence Handling and Forensic Reporting** Evidence Handling - Faraday's Bag, Characteristics of an Evidence, Types of Evidence, Evidence Handling Methodology, Chain of Custody. Forensic Reporting - Goals of a Report, Layout of an Investigative Report, Guidelines for writing a report, Sample Forensic Report.	**6**	**CO6**

Text Books:

1. EC-Council -Ethical Hacking and Countermeasures Attack Phases, Cengage.
2. Michael Gregg, Jesse Versalone - EC-Council –CHFI Study Guide, Cengage.
3. Nilakshi Jain & Kalbande - Digital Forensics, Wiley.
4. Kevin Mandia, Chris Prosise - Incident Response & Computer Forensics, Wiley.

Reference Books:

1. EC-Council – CEH v12 Study Guide, Cengage.
2. Nelson, Phillips, Steuart – Guide to Computer Forensics and Investigations, Cengage.
3. William Stallings - Computer Security Principles and Practice, Sixth Edition, Pearson Education.
4. Raj & Raman – Ethical Hacking, McGraw Hill.
4. Stuttard, Dafydd – Web Application Hacker's Handbook, Wiley.
5. Kevin Smith - Hacking How to Hack - The ultimate Hacking Guide, Hacking Intelligence

6. Kevin Beaver-Hacking for dummies, Wiley.
7. Michael Gregg - Build your own Security Lab, Wiley India.

Online References:

1. https://freevideolectures.com/course/4070/nptel-ethical-hacking
2. https://owasp.org/www-project-top-ten/
3. https://www.computersecuritystudent.com/
4. http://www.opentechinfo.com/learn-use-kali-linux/
5. https://pentesterlab.com
6. https://www.exploit-db.com/google-hacking-database
7. https://www.youtube.com/watch?v=3wwaYc_Yuhc
8. https://www.youtube.com/watch?v=mnd1NnyyOvc

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ICPEC6023	Augmented and Virtual Reality	20	20	60	1	2	100	

Prerequisite: Concepts of Computer Graphics	
Course Objectives: The course aims to	
1	Understand the fundamental concepts of Augmented Reality (AR), Virtual Reality (VR), including their hardware components and real-world applications.
2	Analyse VR environments, focusing on technologies such as 3D modelling, tracking, navigation and interfaces.
3	Provide a comprehensive understanding of Augmented Reality (AR) system architectures, tracking methods, SLAM and development frameworks.
4	Explore advanced applications and case studies and future trends in AR, VR.
Course Outcomes: Learners will be able to	
1	Understand the concepts of Virtual Reality (VR) and hardware components.
2	Familiarize 3D model tracking, navigation and interfaces.
3	Interpret different modelling techniques used in Virtual Reality systems.
4	Learn basics of AR, various displays and visual perception.
5	Analyse various tracking techniques in computer vision of AR.
6	Explore applications, case study and future trends in AR/VR.

Module	Detailed Contents	Hrs.	CO Mapping
01	**VR Technology Introduction** Defining Virtual Reality, Key elements of virtual reality, experience in Virtual Reality, Telepresence, Augmented Reality and Cyberspace. Bird's-Eye View: Hardware, Software, Human Physiology and Perception, Interaction between physical and digital objects	08	CO1
02	**3D tracking and Navigation** Input Devices: Trackers, Navigation, and Gesture Interfaces, Three-dimensional position trackers, navigation and manipulation, interfaces and gesture interfaces. Output Devices: Graphics displays, sound displays & haptic feedback.	08	CO2
03	**Different Modelling in VR** Geometric modeling, Kinematics modeling, Physical modeling, Behaviour modeling, Model management.	07	CO3

04	**Introduction to Augmented Reality (AR)** Definition and Scope, Brief history of AR and Examples. Displays: Audio displays, Visual displays, Haptic, tactile and tangible displays, olafactory and Gustatory displays. Visual perceptions: Requirement and characteristics **Self Learning Topic: T**racking, Calibration and Registration.	**06**	**CO4**
05	**Computer Vision for AR** Marker tracking, Multiple camera infrared tracking, Natural feature tracking by detection, Incremental tracking, Simultaneous Localization and Mapping, Outdoor tracking	**07**	**CO5**
06	**AR Application Requirements, Case Study & Future** AR application requirements, Case study: Wearable Augmented reality setup. Future: Confluence of VR and AR-Augmented Humans. **Self Learning Topic:** Emerging trends: XR (Extended Reality), Metaverse, wearable devices.	**06**	**CO6**

Textbooks:

1. Grigore C. Burdea and Philippe Coiffet, Virtual Reality Technology, 3rd Edition, Wiley-IEEE Press, 2020.
2. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2019.
3. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles and Practice", Pearson Education, Inc.2016 Edition.

References:

1. William R. Sherman and Alan B. Craig, Understanding Virtual Reality Interface, Application and Design,2nd Edition, Morgan Kaufmann Publishers, Elsevier, 2019.
2. Chetankumar G. Shetty, "Augmented Reality: Theory, Design and Development," Mc Graw hill,2020 Edition
3. Paul Mealy and John Paul Mueller, Augmented Reality for Dummies, Wiley, 2018.
4. Coursera: "Introduction to XR: AR, VR, and MR Foundations" (University of Michigan)
5. https://nptel.ac.in/courses/106106138
6. https://lavalle.pl/vr/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
CEMDM601	Big Data Computing	20	20	60	1	2	100	

Prerequisite: Data base management system	
Course Objectives: The course aims to	
1	Describe an Overview of an exciting growing field of Big Data Analytics.
2	Discuss the tools required to manage and analyze big data like Hadoop, NoSQL, Map Reduce.
3	Apply the fundamental techniques in achieving big data analytics with scalability and streaming capability
4	Discuss the several types of big data like social media, web graphs and data streams.
Course Outcomes: Learners will be able to	
1	Describe the key issues in big data management and its associated applications in intelligent business and scientific computing
2	Outline fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce and NoSQL in big data analytics.
3	Predict the business models and scientific computing paradigms, and apply software tools for big data analytics
4	Describe adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc
5	Develop applications for Big Data analysis using Hadoop and NoSQL etc.
6	Design and implement successful Recommendation engines for enterprises.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Big data Analytics**	2	CO1
	Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications		
02	**Hadoop**	6	CO2
	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.		
03	**NoSQL**	7	CO3
	Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies. NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analysing big data with a shared-nothing architecture; Choosing distribution models: master-		

	slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems, Managing MongoDB database with CRUD operations		
04	**Map Reduce**	**6**	**CO4**
	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures Algorithms Using MapReduce: MapReduce Wordcount Program, Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce .		
05	**Techniques in Big Data Analytics**	**14**	**CO5**
	Finding Similar Item: Nearest Neighbour Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard, Cosine , Edit and Hamming Distance with its Examples Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter. Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu		
06	**Big Data Analytics Applications**	**7**	**CO6**
	Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Networks. Clustering of Social Graphs: Applying Standard Clustering Techniques, counting triangles using Mapreduce.		

Text Books:

1. Radha Shankarmani and M Vijayalakshmi —Big Data Analytics, Wiley
2. Alex Holmes —Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly —Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, —Hadoop in Action‖, Dreamtech Press
3. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series
4. https://onlinecourses.nptel.ac.in/noc25_cs131/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETMDM601	Digital Image Processing	20	20	60	1	2	100	

Prerequisite: Basic concepts of Mathematics and Digital Communication	
Course Objectives: The course aims to	
1	Familiarize fundamental concepts of Digital Image Processing
2	Learn Spatial and Frequency domain Image enhancement techniques
3	Gain knowledge of Image Segmentation and Image Compression
4	Understand Image Morphology, Restoration, Descriptors and Object recognition applications
Course Outcomes: Learners will be able to	
1	Understand the fundamentals of Digital Image Processing and perform basic operations on image.
2	Analyze and apply Spatial and Frequency domain Image enhancement techniques.
3	Illustrate image segmentation techniques based on principle of discontinuity and similarity using various algorithms.
4	Describe and analyze various digital image compression techniques.
5	Demonstrate morphological operations, image restoration model and various shape descriptors
6	Apply image processing algorithms for object recognition applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** Fundamental steps in Digital Image Processing, Representation of a Digital Image, Tonal and Spatial Resolutions, Pixel relationships - neighbors, adjacency, connectivity, distance measures, Basic image operations - arithmetic, logical, geometric transformations, Image File Formats: BMP, TIFF and JPEG, RGB Color model. **Self Learning Topic:** Sampling and Quantization	06	CO1
02	**Image Enhancement** Spatial domain enhancement techniques – Image Negative, Contrast Stretching, Thresholding, Gray level transformation, Histogram Equalization, Histogram Specification. Spatial filtering – Smoothing, Sharpening, Highboost and Median Filters. Frequency domain enhancement techniques - Introduction to 2-D DFT and	09	CO2

	IDFT, Frequency domain filtering - Low pass, High pass and Homomorphic filtering.		
03	**Image Segmentation** Fundamentals of segmentation and edge detection, Thresholding techniques - global, local, and adaptive thresholding, Edge based segmentation- Robert, Sobel, Prewitt, Laplacian, and Canny operators, Region-based segmentation - region growing, splitting, and merging.	**08**	**CO3**
04	**Image Compression** Fundamentals of image compression, Types of redundancy, Fidelity criteria, Lossless compression techniques: Runlength coding, Huffman coding, Bitplane coding, Arithmetic coding, Introduction to DCT, Wavelet transform, Lossy compression techniques: Transform coding, Image and Video Compression Standards – JPEG, MPEG.	**08**	**CO4**
05	**Morphological Operations, Image Restoration and Description** Introduction to mathematical morphology, Erosion and Dilation, Opening and Closing operations, Hit-or-Miss transform, Boundary Extraction and Region Filling, Thinning and Thickening, Image Restoration Models, Boundary and Region Descriptors, Shape descriptors, Fourier descriptors, Moments, Skeletons.	**07**	**CO5**
06	**Object Recognition and Applications** Feature extraction, Patterns and Pattern Classes, Representation of Pattern classes, Types of classification algorithms. Applications- Biometric Authentication, Character Recognition, Content based Image Retrieval, Remote Sensing. **Self Learning Topic:** Medical application of Image processing	**04**	**CO6**

Text Books:

1. Gonzales and Woods, “Digital Image Processing”, Pearson Education, India, Fourth Edition 2018
2. Anil K.Jain, “Fundamentals of Image Processing”, Prentice Hall of India, Second Edition 2004
3. Pratt W.K, “Digital Image Processing”, Third Edition, John Wiley, New York, 2002

References:

2. Kenneth R. Castleman, Digital Image Processing, Pearson, 1996.
3. B. Chanda and D. Dutta Majumder, Digital Image Processing and Analysis, PHI, 2011.
4. S. Jayaraman, E. Esakkirajan and T. Veerkumar, “Digital Image Processing”, Third Edition, Tata McGraw Hill Education Private Ltd, 2009
5. Digital Image Processing, IIT Kharagpur, Prof. P.K. Biswas Link: https://nptel.ac.in/courses/117105079

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ARMDM601	Robotics	20	20	60	1	2	100	

Prerequisite: Engineering mechanics, Electrical engineering	
Course Objectives: The course aims to	
1	To acquaint with significance of robotic system in agile and automated manufacturing processes.
2	To make conversant with robotic elements/ peripherals, their selection and interface with manufacturing equipment's
3	To study the basics of robot kinematics
Course Outcomes: Learners will be able to	
1	Understand the basic components and types of robots.
2	Analyze and model robotic arms, manipulators, and end-effectors.
3	Acquire skills in image processing and object recognition for robotic applications.
4	Apply kinematic and dynamic analysis to robotic systems
5	Acquire skills of robot intelligence and its role in autonomous decision-making.
6	Understand social, ethical, and economic impacts of robotics on labour, productivity, and society.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction:** Automation & its Overview, Introduction to robotics: Robotic system & Anatomy, Classification of robots and Robot degrees of freedom (DoF) and joint & join types.	04	CO1
02	**Drives & Peripherals End Effecters:** **Drives** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system. **Robot & its Peripherals End Effecters**: Type mechanical and other grippers, Tool as end effecter. Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment	08	CO2
03	**Machine vision & Programming for Robots:** **Machine vision** Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications. **Programming for Robots** Method, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	09	CO3

04	**Robot Kinematics & Robot Dynamics:** Robot Kinematics Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics. Introduction to wheeled and legged robots including humanoids.	**08**	**CO4**
05	**Robot Intelligence & Task Planning:** Robot Intelligence & Task Planning Introduction, State space search, Problem reduction, use of predictive logic, Means Ends Analysis, Problem solving, Robot learning and Robot task planning.	**07**	**CO5**
06	**Robot application:** Robot application in manufacturing Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, social issues & Economics of Robotics. Introduction to AI in Robotics industrial safety standards in robotics, Recent trends in robotics like service, Medical, humanoid robot, Softrobotics.	**06**	**CO6**

Text Books:

1. Fundamentals of Robotics, Larry Health
2. Robotics for Engineers, Yoram Koren , Mc Graw hill.
3. Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel, Ordey,Mc Graw Hill.
4. Robotic technology & Flexible Automation, S R Deb. TMH.
5. Robot Analysis & Control, H Asada, JJE Slotine.
6. Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.
7. Handbook of IndustrialRobotics, Ed. Shimon. John Wiley
8. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to AutonomousMobile Robots”, Bradford Company Scituate, USA

References:

1. https://onlinecourses.nptel.ac.in/noc23_me07/preview
2. https://onlinecourses.nptel.ac.in/noc25_me166/preview
3. https://onlinecourses.nptel.ac.in/noc19_cs47/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

4. Assignment: 5 Marks
5. Quiz/Open book test/Presentation: 10 Marks
6. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ITMDM601	Microcontrollers and Application	20	20	60	1	2	100	

Prerequisite: Digital Electronics, Number system	
Course Objectives: The course aims to	
1	understand the features and architecture of PIC 18 microcontroller and Ardino UNO
2	Introduce assembly programming knowledge for PIC 18 microcontroller
3	Impart embedded programming knowledge for PIC 18 microcontroller using C
4	Introduce various applications using microcontroller-based system
Course Outcomes: Learners will be able to	
1	Explain difference between microprocessor and microcontroller architecture and memory
2	Understand PIC 18 instruction and assembly level Programing
3	Describe the timer, counter and interrupt module of PIC 18 with assembly program
4	Explain the serial and parallel I/O with simple assembly program
5	Understand the Arduino UNO programming
6	Write a C program for various applications of microcontrollers.

Prerequisite: Knowledge of No. system, digital electronics, programming basics			
Module	**Detailed Contents**	**Hrs**	**CO Mapping**
01	**Introduction to Microcontroller** Block diagram of generic microcontroller, Microcontroller versus Microprocessor, A brief history of PIC microcontroller, Overview of PIC 18 family and features, Internal Bus structure of PIC microcontroller, Clock frequency, machine cycle and instruction cycle PIC18 microcontroller programming model, Bus architecture, program memory and data memory organization, Special Function Registers (SFRs), General Purpose Registers (GPRs) , program counter. CPU registers: Working Register (Wreg), Status Register, Bank Select Register (BSR), Instruction Decoder **Self-learning Topic**: Memory Pointers, Program ROM, Data ROM	6	CO1
02	**PIC18F Instruction Set** Pipelining. (conceptual overview only) Instructions and Assembly Programs: Instruction Set, Instruction formats, Addressing modes, Assembler Directives, Assembly programs. (Assembly programs are restricted to basic arithmetic, logical and data transfer operations only)	9	CO2

03	**PIC 18 Timer/counters and interrupt** Timer Module: Basic Concept of Timers and counters, Timer Registers, Control Registers, 8 bit and 16 bit operation (only for Timer 0), CCP module (Capture, Compare and PWM), Watch dog Timer. Interrupt Module: Basic concept of Interrupt, PIC 18 Interrupts, Interrupt versus polling, Interrupt sources, Interrupt vector, Interrupt service routine, Interrupt process, RCON, INTCON, IPR1 and PIE1. **Self Learning Topic:** Watch dog Timer, other SFRs of interrupt module.	6	CO3
04	**Parallel Ports and Serial Communication** IO PORT Module: Basic concept of I/O interfacing, PORT Registers, TRIS Registers, LAT Registers, Simple input /output peripheral interfacing (switches & LEDs). Serial communication: Basics of serial communication, Data framing, USART module, SPBRG, TXREG, RCREG, TXSTA, RCSTA, PIR1.	9	CO4
05	**Introduction to Arduino** Introduction to Arduino -UNO board, Analog and digital Pins, Programming structure of Arduino, basics of C programming, programming Arduino with sensor interfacing, LED blinking, LCD interfacing.	6	CO5
06	**Application of Microcontroller** Interfacing matrix keyboard and Seven segments LED display, LCD Interfacing, ADC Interfacing, Traffic signal controller, DC motor interfacing, Stepper motor interfacing, PWM signal generation. **Self learning topics:** LCD Interfacing, ADC Interfacing.	6	CO6

Text Books:-

1. Ramesh Gaonkar, “Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC 18 Microcontroller Family)”, Penram International publications (Ind) Pvt. Ltd.
2. Ali Mazidi, Rolind D Mckinlay and Danny Causey , “PIC Microcontroller and Embedded Systems”, Pearson Education ltd., 2015
3. Robert B. Reese, “Microcontroller from Assembly Language to C using PIC18FXX2”, Davinici Engineering press.
4. Simon Monk, “Programming Arduino: Getting started from Sketches, second Edition,

Reference Books:-

1. Han Way Huang, “PIC Microcontroller: An Introduction to Software and Hardware Interfacing”, Cengage Learning, 2005.
2. NPTEL Course: **Microprocessors And Microcontrollers** By Prof. Santanu Chattopadhyay, Dept. of Electrical Engineering, IIT Kharagpur:- Web link- https://nptel.ac.in/courses/108/105/108105102/
3. https://www.arduino.cc/education/certification/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

i. Assignment: 5 Marks
ii. Quiz/Open book test/Presentation: 10 Marks
iii. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
MEMDM601	Automobile Systems	20	20	60	1	2	100	

Prerequisite: Engineering Mechanics	
Course Objectives: The course aims to	
1	Understand the major systems and subsystems in modern automobiles.
2	Analyse the working principles of vehicle drivetrain, chassis, braking, steering and suspension systems.
3	Apply mechanical engineering fundamentals (mechanics, strength of materials, kinematics) to vehicle systems.
4	Understand the fundamentals of electric/hybrid vehicle (EV) systems and how they differ from conventional vehicles.
5	Select appropriate components/materials for automotive applications and appreciate trends in automotive technology (EV, ADAS).
Course Outcomes: Learners will be able to	
1	Identify and classify automotive clutches and transmission systems.
2	Explain the working of Driveline, Final Drive & Differential.
3	Explain Steering mechanisms, Wheels, Tyres & Suspension.
4	Identify and classify Braking Systems & Chassis Layout in Automobile.
5	Identify and classify Vehicle Body, Aerodynamics, Materials for Automobile.
6	Relate emerging technologies (electric/hybrid vehicles, regenerative braking, ADAS) to conventional systems.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Clutch and Transmission Systems** Purpose of clutch & transmission in a vehicle, Single-plate, multi-plate clutches, centrifugal clutches, Manual transmissions: sliding mesh, constant mesh, synchromesh. Automatic transmissions: torque converter, fluid coupling Continuously Variable Transmission (CVT), Introduction to EV / hybrid transmission layouts.	07	**CO1**
02	**Driveline, Final Drive & Differential** Driveline components: propeller shaft, universal joints, driveshafts. Differential: open, limited slip, locking types Rear axle construction for different vehicles (2WD, 4WD) Introduction to EV/Hybrid drivetrain configurations (e.g., single motor, dual motor, hub motors)	08	**CO2**

03	**Steering, Wheels, Tyres & Suspension** Steering geometry, types of steering mechanisms (rack & pinion, recirculating ball) Power steering systems, steer-by-wire Tyre construction, types, loads; wheel & hub assembly Suspension systems: leaf, coil, air, independent suspension Vehicle dynamics basics: camber, toe, roll, pitch EV/HV implications: regenerative braking effect on suspension, weight distribution, hub motors	08	**CO3**
04	**Braking Systems & Chassis Layout** Braking fundamentals: friction brakes, drum vs disc Hydraulic and pneumatic braking systems ABS, EBD, regenerative braking (in EV/HV) Chassis types: ladder, monocoque, space-frame Vehicle layouts: FR, FF, MR, RR, 4WD, AWD Impact of EV architecture on chassis-body design (battery placement, low centre of gravity)	07	**CO4**
05	**Vehicle Body, Aerodynamics, Materials** Vehicle body structures, loads, crashworthiness Aerodynamics basics: drag, lift, side-wind, airflow Materials in automotive industry: steels, aluminium, composites Integration of thermal management systems for EV	05	**CO5**
06	**Electric & Hybrid Vehicle Systems** Overview of electric vehicle (EV) and hybrid architectures, Batteries: types, performance metrics Electric motors / motor drives: types (DC, AC, PMSM, etc.) Power electronics: inverters, converters, charger systems, Charging infrastructure, vehicle-to-grid (V2G) & future trends. Comparison of conventional vs EV systems: lifecycle, maintenance, Sustainability.	07	**CO6**

Text Books:

1. A Textbook of Automobile Engineering by S. K. Gupta.
2. A Textbook of Automobile Engineering by R. K. Rajput.
3. Automobile Engineering by G. B. S. Narang
4. Automobile Engineering Vol I and II by Kirpal Singh.

References:

1. Heitner, J. J., Fundamentals of Vehicle Dynamics and Driveline Systems.
2. Heldt, P. M., Automotive Chassis & Body.
3. Crouse, W. H. & Anglin, D. L., Automotive Mechanics.
4. Ganesan, V., Electric Vehicles and Hybrid Vehicles.
5. Husain, I., Electric and Hybrid Vehicles: Design Fundamentals.

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

i. Assignment: 5 Marks
ii. Quiz/Open book test/Presentation: 10 Marks
iii. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
EEMDM601	Electric Vehicle Technology	20	20	60	1	2	100	

Prerequisite: Sustainability and environment, Electrical Machine.	
Course Objectives: The course aims to	
1	Describe the history and evolution of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for a sustainable future.
2	Identify and describe the principles of various EV/HEVs drive train topologies.
3	Develop an understanding of EV/HEV Electric Machines drives for Propulsion Applications and Energy Sources.
4	Model, analyze and design electric and hybrid electric vehicles drive train and to understand energy management strategies.
Course Outcomes: Learners will be able to	
1	Identify and describe the history and evolvement of electric & hybrid electric vehicles.
2	Identify and describe the principles of various EV/HEVs drive train topologies.
3	Select electric propulsion system components for EV/HEV drives for the desirable performance and control.
4	Compare and evaluate various energy sources and energy storage components for EV/HEV
5	Model, analyze and design EV/HEV drive train with energy management
6	Recognize the need to adapt and engage in operations EV/HEV with the absolute technological change in the transportation system for a sustainable future.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** 1.1 Basics of vehicle mechanisms, history of Electric vehicles (EV) and hybrid electric vehicles (HEV), importance of EV and HEV. 1.2 Power/Energy supplies requirements for EV/HEV applications, transmission characteristics. 1.3 State of the art and Indian and global scenario in EV/HEV. **Self Learning Topic:** Basics of vehicle parts, Bharat standard for vehicle emission.	07	CO1
02	**Drive train Topologies** 2.1 Common parts in ICE drive train and EV/ HEV electric drive train topologies, Classification of HEV (Micro, Mild and Full hybrid) 2.2 basics of hybrid traction system, various hybrid drive-train topologies	07	CO2

	2.3 fuel efficiency analysis for series and hybrid drive train, comparison.		
	Self Learning Topic: Electric motor, single and multi drive system,		
03	**DC and AC machines and Drives for propulsion application**	**07**	**CO3**
	3.1 DC and AC machines used in EV/HEV, Electrical system components. 3.2 Features of DC and AC Motors for EV/HEV propulsion. 3.3 Permanent magnet (BLDC) and switch reluctance machines, configuration and control of drives.		
	Self Learning Topic: comparison of DC and AC machines, induction motor drive characteristics.		
04	**Energy sources for EV and HEV**	**07**	**CO4**
	4.1 Requirements of energy storage in EV/HEV: batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV 4.2 characteristics and comparison of energy sources for EV/HEV 4.3 hybridization of different energy sources.		
	Self Learning Topic: Basics of cell, overview of battery.		
05	**Drive train modeling in EV/HEV**	**07**	**CO5**
	5.1 Modeling and analysis of EV/HEV drive train: Total tractive force calculation, sizing Of motor 5.2 Power electronics drive used in EV/HEV		
	Self Learning Topic: Basic electronic components guidelines.		
06	**Energy management strategies in EV/HEV**	**07**	**CO6**
	6.1 EV/HEV energy management strategies, classification of various energy management strategies. Rule based EMS, optimization methods of EMS. 6.5 Standards for EV and HEV. Case studies.		
	Self Learning Topic: 2w and 3w EV/HEV vehicles.		

Text Books:

1. I. Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press. 2005
3. Sheldon Williamsom, *Energy Management Strategies for Electric and Plug-in Hybrid Vehicles*, Springer 2013
4. J. Larminie and J. Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003
5. C. MI, M. Abul and D. W. Gao, *Hybrid Electrical Vehicle Principles and Application with Practical Perspectives,* Wiley 2011

Reference Books:

1. N.Mohan, T.M.Undeland, and W.P Robbins, *Power Electronics, Converters, Applications & Design,* Wiley India Pvt. Ltd., 2003
2. B. K Bose*, Modern Power Electronics and AC Drives*, Pearson Education 2002 3.
Robert A. Huggins, *Energy Storage*, Springer 2010

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

i. Assignment: 5 Marks
ii. Quiz/Open book test/Presentation: 10 Marks
iii. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

End semester will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPCL601	Blockchain Technology Lab	-	25	25	-	-	50	

Prerequisite:	
Course Objectives: The course aims to	
1	To understand the fundamental principles of blockchain, smart contracts, and distributed ledger technologies.
2	To design, develop, and deploy smart contracts using Solidity and Ethereum tools.
3	To implement and interact with blockchain networks using Truffle, Ganache, and Web3.js.
4	To explore permissioned blockchain networks using Hyperledger Fabric and chaincode deployment.
Course Outcomes: Learners will be able to	
1	Explain the structure and deployment of smart contracts on Ethereum using Remix IDE.
2	Develop and execute Solidity programs implementing logic, mappings, and data handling.
3	Deploy and interact with blockchain contracts using Truffle Suite and Ganache.
4	Create and manage ERC20 and ERC721 tokens on the Ethereum blockchain.
5	Interface blockchain applications with Web3.js and analyze gas optimization techniques.
6	Set up and operate a permissioned blockchain network using Hyperledger Fabric and chaincodes.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Create, compile, and deploy a simple smart contract using Remix IDE.	**CO1**
02	Develop a contract to store and retrieve integer data on the Ethereum blockchain.	**CO1**
03	Write a Solidity contract that checks voting eligibility (age-based logic).	**CO2**
04	Create a Solidity contract that stores student records using arrays and mapping.	**CO2**
05	Deploy a Solidity contract using Truffle Suite and interact with it locally via Ganache.	**CO3**
06	Implement a fungible ERC20 token using Open Zeppelin and deploy it to Ethereum testnet.	**CO4**

07	Create a non-fungible token (NFT) using the ERC721 standard.	**CO4**
08	Use Web3.js to connect a web interface with a deployed smart contract.	**CO5**
09	Design a decentralized crowdfunding DApp with funding and refund logic.	**CO5**
10	Compare gas costs for similar contracts with and without optimization.	**CO5**
11	Launch the Fabric test network using Docker containers and Fabric CLI.	**CO6**
12	Write, install, approve, and commit a chaincode that manages asset transfers.	**CO6**
13	Perform read and write operations using Fabric CLI commands.	**CO6**
14	Connect to a Fabric network using Node.js SDK and submit transactions programmatically.	**CO6**
15	Set up a two-organization Fabric network with private data collections.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPCL602	Cryptography and Network Security Lab	-	25	25	-	-	50	

Prerequisite: Computer Network Lab, Concepts of Number Theory	
Course Objectives: The course aims to	
1	Provide hands-on experience in implementing various classical and modern cryptographic algorithms.
2	Understand the practical aspects of encryption, decryption, hashing, and digital signatures.
3	Demonstrate secure communication protocols and analyse packet-level security mechanisms.
4	Explore and configure network security mechanisms such as firewalls, VPNs, and intrusion detection.
Course Outcomes: Learners will be able to	
1	Implement and demonstrate various classical ciphers for data encryption and decryption.
2	Apply symmetric and asymmetric key algorithms (DES, AES, RSA, ECC) for securing data.
3	Analyze and verify message integrity using hash functions (MD5, SHA).
4	Create and verify digital signatures and certificates using tools like OpenSSL.
5	Capture, inspect, and interpret secure packets using Wireshark and network monitoring tools.
6	Configure and test network security mechanisms such as firewalls and VPNs.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Implement Caesar Cipher, Playfair Cipher, and Vigenère Cipher.	**CO1**
02	Implement DES and AES encryption and decryption using Python.	**CO2**
03	Implement RSA algorithm for encryption and decryption.	**CO2**
04	Demonstrate Diffie-Hellman key exchange between two nodes.	**CO2**
05	Generate and verify digital signatures using RSA.	**CO2**
06	Implement hashing using MD5 and SHA algorithms.	**CO3**
07	Demonstrate SSL/TLS secured communication using OpenSSL tools.	**CO4**
08	Implement a setup of https server using OpenSSL.	**CO4**
09	Create a technique to hiding confidential information with image.	**CO4**

10	Digital signature creation and verification using OpenSSL or Python.	**CO4**
11	Implement secure file transfer using SCP/SSH	**CO5**
12	i) Download and install nmap. ii) Use it with different options to scan open ports, perform OS fingerprinting, Ping scan tcp port scan, udp port scan etc	**CO5**
13	Analyze packet encryption using Wireshark (TLS/SSL capture).	**CO5**
14	Set up a VPN service that allows secure remote access (or site-to-site) and test encryption and access controls.	**CO6**
15	Configure a simple firewall using Linux iptables.	**CO6**

Online reference:

1. https://cse29-iiith.vlabs.ac.in/#

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL6011	**AI with Robotics lab**	-	25	-	-	-	25	

Prerequisite: Machine Learning, IoTAP	
Course Objectives: The course aims to	
1	Understand the interfacing of sensors and actuators to ensure accurate measurement and control.
2	Integrate vision into robot perception; understand sensor fusion, trajectory planning & control in robotic/IoT contexts.
3	Develop the ability to design and implement intelligent systems using various AI techniques such as search, reasoning, and probabilistic models.
4	Provide hands-on experience in applying AI algorithms for real-world problem-solving and decision-making
Course Outcomes: Learners will be able to	
1	Implement Sensor & actuator interfacing, microcontroller/SoC setup.
2	Integrate vision module with robotic actuation (e.g., object detection, triggers motion)
3	Implement and control a mobile robot along a trajectory using encoders/odometry.
4	Implement and analyze different AI search algorithms for optimal problem-solving.
5	Apply reasoning and decision-making techniques using logic and probabilistic approaches.
6	Design intelligent agents and game-playing systems that demonstrate rational and adaptive behaviour.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	Implementation of robot kinematics for various inputs in simulation.	**CO1**
2	Interfacing Sensors and Actuators for Robotic Control using Microcontroller/Embedded Board/ Arduino/Raspberry Pi/NVIDIA Jetson)	**CO1**
3	Vision tasks: object detection, stereo vision, tracking using cameras + hardware.	**CO2**
4	Control loop experiments on hardware: motor control, line following, path tracking, mobile robot navigation.	**CO3**
5	Implementation of sensor fusion (IMU + odometry) and basic motion control of a mobile robot kit.	**CO1, CO3**

6	Design and train a simple vision-based perception module (e.g., object detection) and integrate with robotic actuation.	**CO2, CO3**
7	Implementation of State Space Formulation and PEAS Representation for various AI applications.	**CO4**
8	Implementation of Uninformed Search Algorithms such as Breadth-First Search (BFS) and Depth-First Search (DFS).	**CO4**
9	Implementation of Informed Search Algorithms such as Greedy Best-First Search and A* Search.	**CO5**
10	Implementation of Game Playing Algorithms using Min-Max and Alpha-Beta Pruning techniques.	**CO5**
11	Implementation of Bayesian Belief Network for reasoning under uncertainty and decision-making.	**CO5**
12	Final mini-project integrating at least perception + control + autonomy aspect, where students build or simulate a robot doing a complete task.	**CO1-CO6**

Online reference - http://vlabs.iitkgp.ac.in/mr/

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL6012	Application Security and Secure Coding Principles Lab	-	25	-	-	-	25	

Prerequisite: Operating Sytstem, Computer Network Fundamentals	
Course Objectives: The course aims to	
1	Understand the fundamental concepts of application and software security
2	Identify and analyze common web, mobile, and cloud application vulnerabilities through secure coding and testing practices.
3	Apply secure coding principles and defensive programming techniques to build secure applications.
4	Perform application security testing and adopt modern secure development practices such as DevSecOps.
Course Outcomes: Learners will be able to	
1	Explain the fundamental concepts of application and software security, and identify common threats and vulnerabilities.
2	Analyze and exploit common web application vulnerabilities and demonstrate appropriate mitigation techniques.
3	Implement secure coding practices including input validation, output encoding, authentication, and session management.
4	Perform static and dynamic security testing using tools like SAST, DAST, and interpret results for secure code improvement.
5	Assess security in mobile and cloud environments and implement basic identity and access management controls.
6	Integrate security throughout the software development lifecycle and perform an end-to-end application security assessment.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of Application Security Fundamentals and STRIDE Threat Modeling	**CO1**
02	Demonstration of SQL Injection Vulnerability and Secure Query Implementation	**CO2, CO3**
03	Demonstration of Cross-Site Scripting (XSS) and Output Encoding Techniques	**CO2, CO3**

04	Implementation of CSRF Attack and Protection Mechanism	**CO2, CO3**
05	Secure Authentication and Session Management	**CO3**
06	Input Validation and Output Encoding using Secure Coding Practices	**CO3**
07	Static Application Security Testing (SAST) on Source Code	**CO4**
08	Dynamic Application Security Testing (DAST) using OWASP ZAP	**CO4**
09	Analysis of Mobile Application Security	**CO5**
10	Cloud Application Security and Identity Management	**CO5**
11	Capstone Project: End-to-End Application Security Assessment	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Oral Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICPEL6013	Software Engineering Lab	-	25	-	-	-	25	

Prerequisite: Object Oriented Programming with Software Engineering practices.	
Lab Objectives: The course aims to	
1	Apply an appropriate software process model to a small project.
2	Elicit and document requirements and build core analysis models.
3	Create key design artifacts using good design principles.
4	Perform size/effort estimation and prepare a basic project schedule.
5	Practice project planning, control and risk management.
6	Design and execute test cases and apply basic QA checks.
Lab Outcomes: Learners will be able to	
1	Select/tailor a process model and define a bounded problem scope with activities
2	Produce an SRS and analysis models.
3	Draft design artifacts using concrete design concepts and principles.
4	Compute effort and derive project schedule.
5	Prepare an RMMM plan, track progress, and manage configuration.
6	Write test cases mapped to SRS and execute simple QA checks.

Suggested List of Experiments

Sr. No.	List of Experiments (Assign the case study/project as detail statement of problem to a group of three/four students. Laboratory work will be based on course syllabus with minimum 10 experiments. Open-source computer-aided software engineering (CASE) tools can be used for performing the experiments.)	CO Mapping
01	Write problem statement to define the project title with bounded scope of the project.	**CO1**
02	Select relevant process model to define activities and related tasks set	**CO1**
03	Gather application specific requirements for assimilate into RE (Requirement's engineering) model.	**CO2**
04	Prepare broad SRS (software requirement software) for the project.	**CO2**
05	Write use-cases and draw use-case diagram.	**CO2**

06	Draw the activity diagram to represent flow from one activity to another for software development.	**CO2**
07	Create DFDs (data flow diagram), Decision tables and E-R (entity-relationship) diagram.	**CO2**
08	Draw class diagram and Sequence diagram, State Transition Diagram	**CO3**
09	Create decision table for a project.	**CO3**
10	Calculate size of the project using Function point metric.	**CO4**
11	Calculate cost of the project using COCOMO II approach.	**CO4**
12	Track progress of the project using Timeline charts/ Gantt charts.	**CO4**
13	Project management using any open-source tools like Jira.	**CO5**
14	Identify risks involved in the project and prepare RMMM (RMMM-Risk Management, Mitigation and Monitoring) plan.	**CO5**
15	Write test cases to validate requirements from SRS document	**CO6**
16	Prepare test cases for Black Box Testing.	**CO6**

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
CEMDML601	Big Data Computing Lab	-	25	-	-	-	25	

Prerequisite: DBMS	
Course Objectives: The course aims to	
1	Describe an overview of an exciting growing field of Big Data analytics.
2	Discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3	Explain the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4	Tell the tools that will help them to solve complex real-world problems in decision support.
Course Outcomes: Learners will be able to	
1	Explain the motivation for big data systems and identify the main sources of Big Data in the real world.
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store, retrieve and process Big Data for Analytics.
3	Build several Data Intensive tasks using the Map Reduce Paradigm
4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data
5	Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.
6	Design and implement successful Recommendation engines for enterprises.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Case Study: on Study of Hadoop ecosystem	CO1
02	Programming exercises on Hadoop Using Hive, Pig, Hbase, Sqoop NOSQL, MongoDB	CO2
03	Implementing simple algorithms in MapReduce Matrix, multiplication, Aggregates, joins, sorting, searching etc.	CO3
04	Implementing Algorithms using MapReduce (Any 2)	CO3
05	Implementing Frequent Item set Mining	CO4
06	Implementing Clustering algorithms Implementing Classification Algorithms	CO5
07	Big Data Applications (Any 2) ● Implementing Analytics on data streams ● Implementing Social Network Analysis Algorithms	CO6
08	Implementing Web Graph Algorithms Implementing	CO6

	recommendation Engines	
09	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines (list of datasets also given in the text book)	CO5,CO6

Useful Links:

1 https://www.coursera.org/learn/hadoop#syllabus

2 https://www.coursera.org/learn/introduction-mongodb#syllabus

3 https://www.coursera.org/learn/data-visualization-tableau?specialization=data-visualization#syllabus

4 https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop#syllabus

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETMDML601	Digital Image Processing Lab	-	25	-	-	-	25	

Prerequisite: Python Programming Skill Lab	
Course Objectives: The course aims to	
1	Gain practical experience with various operations on digital image.
2	Apply Image enhancement, Image Segmentation, and Image Compression techniques on digital image.
3	Perform morphological operations and compute region and shape descriptors.
4	Strengthen the ability to apply image processing techniques for the given real-world problem.
Course Outcomes: Learners will be able to	
1	Demonstrate basic operations on Image.
2	Implement Spatial and Frequency domain Image enhancement techniques.
3	Perform various image segmentation techniques.
4	Implement and analyze various digital image compression techniques.
5	Demonstrate morphological operations, region and shape descriptors.
6	Apply image processing algorithms for object recognition and applications.

Suggested List of Experiments

Implementation can be carried out in MATLAB / Scilab /c / Python (OpenCV)

Sr. No.	List of Experiments	CO Mapping
01	Perform Image reading, displaying, and writing	**CO1**
02	Perform Image transformations like rotation, scaling, and translation	**CO1**
03	Implement Histogram equalization	**CO2**
04	Implement Spatial Domain Filtering: Smoothing and Sharpening Filters	**CO2**
05	Implement Frequency domain filtering: Low-pass and High-pass Filters	**CO2**
06	Implement Edge based segmentation- Sobel, Prewitt, Laplacian, and Canny operators	**CO3**

07	Implement region growing and watershed segmentation	**CO3**
08	Image segmentation using global Thresholding Algorithm	**CO3**
09	Implement RLE and Huffman coding for images	**CO4**
10	Implement Discrete Cosine Transform	**CO4**
11	Implement Wavelet transform	**CO4**
12	Implement Morphological operation – Erosion and Dilation, Opening and Closing operations, Hit-or-Miss transform, Boundary Extraction and Region Filling, Thinning and Thickening	**CO5**
13	Compute region and shape descriptors for given images	**CO5**
14	Perform object detection	**CO6**
15	Case Study on applications of Image Processing	**CO6**

Continuous Internal Evaluation (25 Marks)

4. Lab Performance: 10 Marks
5. In-Semester Practical Exam during lab session: 10 Marks
6. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ARMDML601	ROBOTICS Lab	-	25	-	-	-	25	

Prerequisite: Mechatronics, Theory of Machines, Dynamics of Machinery	
Course Objectives: The course aims to	
1	To acquaint with programming of robots.
2	To learn the implementation of image processing algorithms.
3	To demonstrate the working of machine learning algorithms for data prediction
Course Outcomes: Learners will be able to	
1	Identify and describe the main components and Apply principles of sensors, actuators, and embedded systems to enable real-time decision-making in robots.
2	Obtain the tool to base transformations using software simulations.
3	Program a robotic arm to perform pick-and-place tasks
4	Apply image processing techniques to perform edge detection
5	Implement image segmentation algorithms to isolate and recognize objects
6	Develop and simulate trajectory generation and path planning algorithms for robotic manipulators
7	Formulate and program forward (direct) and inverse kinematics solutions for different robot configurations.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Robot Components and Configuration: Understanding robot types, configurations, and components. using an educational robotic arm, open Ware robotic simulator. Procedure: Identify the components of a robot. Classify robots based on their configuration. Observe actuators, sensors, and controllers. Results: Document robot types and components.	CO1
02	Study different coordinate frames and transformations. Using Open Ware simulation software. Steps: Define the base and tool coordinate frames. Perform homogeneous transformations. Visualize transformed points in Open Ware. Results: Record transformed coordinates.	CO2
03	Program a robotic arm to perform pick-and-place tasks. Apparatus: Educational robotic arm with Open Ware interface. Procedure: Identify pick and place coordinates. Write program using Open Ware commands. Execute and observe operation. Results: Successful pick-and-place operation	CO3
03	Edge detection using image processing (simulation/hardware)Result: Edges in the image successfully detected using gradient-based algorithms.	CO4

04	Segmentation using image processing (simulation/hardware)	CO5
05	Trajectory Generation and Path Planning(simulation/hardware)	CO6
06	Programming the robots to solve direct and inverse kinematics problems	CO7
06	Acquisition of sensor data over cloud using microcontroller (simulation/hardware)	CO5
07	Implementation of Clustering algorithm (K-means / K-medoids)	CO6
08	A Lab course project such as Mobile Robot Line Following, Obstacle Avoidance for Mobile Robot, surveillance robots etc to be developed in a batch of 4 students.	CO1, CO4

Note: Students should do at least 06 experiments from the suggested list.

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ITMDML601	Microcontrollers and Application Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Impart assembly programming of PIC microcontroller
2	Impart assembly programming for I/O interface and timer, counter
3	Impart knowledge of Arduino programming
4	Impart skill of application based microcontroller programming.
Course Outcomes: Learners will be able to	
1	Write and debug simple assembly programs on data transfer
2	Write and debug simple assembly programs on arithmetic and logical instructions
3	Write and debug simple assembly programs on Timers and counters, USART
4	Write and debug Arduino programs
5	Write and debug I/O programming of Arduino and PIC
6	Make application based system using microcontroller

Suggested List of Experiments

Minimum three experiments must be done from each group

Sr. No.	List of Experiments	CO Mapping
Group A	Use at least 3 programs 1. Group of data transfer 2. Addition, Subtraction, Multiplication 3. Time delay using GPRs 4. Time delay using timers 5. Program on USART 6. Conditional and unconditional tasks	CO1 CO2
Group B	1. Square wave generation 2. LED inter facing 3. Blinking LED 4. Serial port programming 5. Counter programming	CO3

Group C	1. Simple arduino programming for addition subtraction	CO4
Group D	2. Arduino programming for LED blinking 3. PIC 18 programming for LCD interface 4. PIC 18/Arduino programming for DC motor interface 5. Any other application of Microcontroller	CO5 CO6

Continuous Internal Evaluation (25 Marks)

1. Minimum 9 experiments and case study hardware project and one assignment are compulsory for the term work.
2. Lab Performance: 10 Marks
3. In-Semester Practical Exam during lab session: 10 Marks
4. Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
MEMDML601	Automobile System Lab	-	25	-	-	-	25	

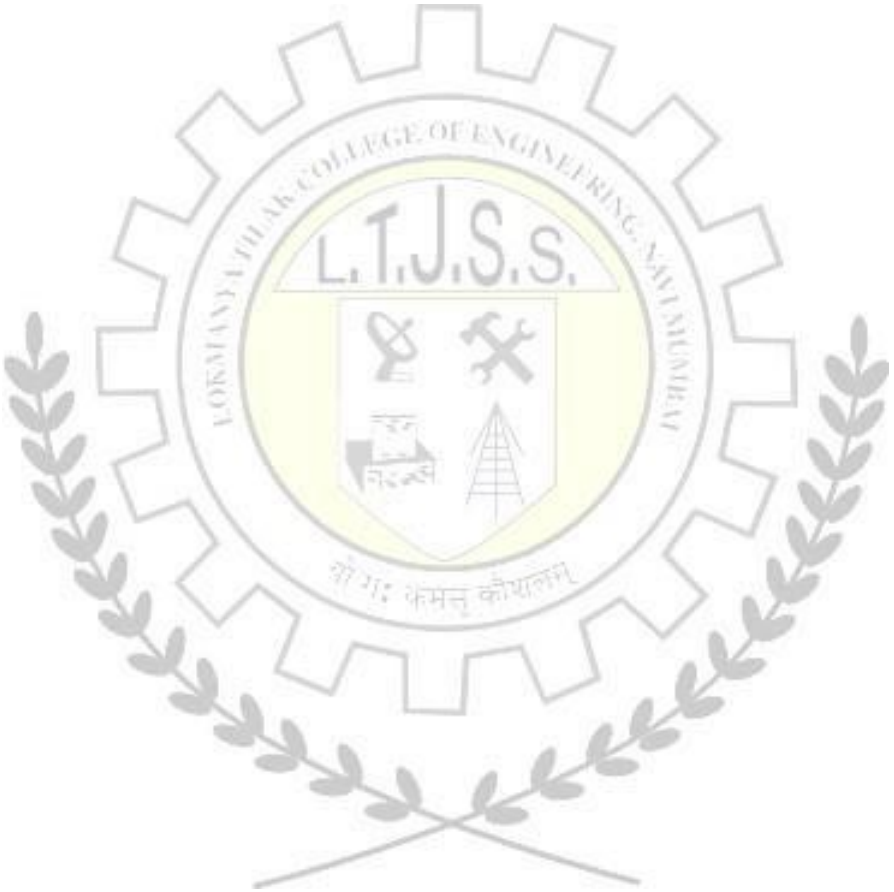
Prerequisite:	
Course Objectives: The course aims to	
1	To study construction, working and performance of key automobile subsystems.
2	To gain hands-on experience with vehicle transmission, steering, suspension, braking, and driveline systems.
3	To introduce modern EV and hybrid powertrain components through simulation and hardware demonstrations.
4	To correlate theoretical concepts with practical automotive systems and diagnostics.
Course Outcomes: Learners will be able to	
1	Identify and explain the construction and working principle of single-plate and multi-plate clutch mechanisms used in vehicles.
2	Compare the working and torque transmission characteristics of manual (synchromesh) and automatic (torque converter/CVT) transmissions.
3	Demonstrate the function and interaction of propeller shaft, universal joint, and differential gear in the driveline system using models.
4	Examine different suspension systems (leaf, coil, air, independent) and analyze their impact on vehicle ride comfort.
5	Distinguish between chassis frame constructions (ladder, monocoque, space-frame) and identify vehicle layouts (FR, FF, 4WD, etc.).
6	Illustrate the architecture and components of Electric Vehicles, including battery, motor, inverter, and charging system.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study and demonstration of single-plate and multi-plate clutch mechanisms.	CO1
02	Comparative study of manual (synchromesh) and automatic transmission (torque converter / CVT).	CO1
03	Study and demonstration of propeller shaft, universal joint, and differential gear using cut section models.	CO2
04	Demonstration of suspension systems.	CO3
05	Analysis of chassis frames (ladder, monocoque, space-frame) and vehicle layout identification.	CO4
06	Study of EV architecture – components like battery, motor, inverter, and charging systems.	CO6

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks



Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
EEMDML601	Electric Vehicle Technology Lab	-	25	-	-	-	25	

Prerequisite: Renewable Energy System and Energy Storage System, Electrical Machines, Power Electronics	
Course Objectives: The course aims to	
1	Study the fundamental concepts and principles of electric and hybrid electric vehicles Drive train topologies
2	Develop a thorough understanding of the key elements of EV/HEV: Electric Machines For Propulsion Applications and Energy Sources
3	Model, analyze and design electric and hybrid electric vehicles drive train and to Understand energy management strategies
Course Outcomes: Learners will be able to	
1	Explore EV and HEV and convention vehicle performance
2	Interpret the salient features and components of Electric and Hybrid electric vehicles
3	Test and analyze various propulsion motor loading under variable speed and torque conditions.
4	Observe and analyze the charging and discharging characteristics of electric vehicle batteries.
5	Describe about the applications of power electronics in electrical vehicles
6	Explore the transportation sustainability

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Basic vehicle simulations on Matlab or any other vehicle simulation software	CO1
02	Study of transmission system through simulation/ experiment	CO1
03	Emission test of conventional vehicle, electric vehicle and hybrid electric vehicle	CO2
04	Develop schematic diagram of hybrid electric vehicle and identify its parts in matlab simulation	CO2
05	Load test of DC series Motor	CO3
06	Testing and analysis of induction motor loading at different speed and torque conditions.	CO3
07	Connect and run the three phase squirrel cage induction motors (in both directions) using the DOL starter/ autotransformer starter.	CO3
08	Rechargeable lithium-ion battery SOC test and other performance	CO4
09	Design and testing of controlled rectifier circuit for battery charging	CO4
10	Prepare a report on batteries used from market survey	CO4
11	study of battery management system through simulation/experiment	CO5
12	Design and testing of battery connected buck / boost converter	CO5
13	List safety procedures and schedule for handling HEVs and EVs	CO6
14	Case study- Compare minimum four vehicles for economic and environmental analysis	CO6
15	Visit to EV/Battery/Motor/Capacitor manufacturing Plant	All COs

Any experiment or simulation related to EV and HEV that helps the students understand the course should be included and added other than the suggested list.

Plant Visit:
Visit to existing EV charging station/ battery manufacturing unit/ EV manufacturing unit.

Term Work: Minimum 8 experiment/simulation must be done for satisfactory completion of the term.

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks

Regularity and Attendance: 5 Marks

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral/ Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ICCEP601	Mini Project II	-	25	25	-	-	50	

Course Objectives: The course aims	
1	To understand the process of identifying needs and transforming them into well-defined problems.
2	To gain experience in collaborative problem-solving within a group setting.
3	To develop the ability to apply fundamental engineering principles to propose effective solutions.
4	To inculcate the process of self-learning and research.
Course Outcomes: Learners will be able to	
1	Identify and define engineering or research problems addressing societal and technological needs.
2	Apply theoretical knowledge and practical skills to design, implement, and analyze solutions through experimentation or simulation.
3	Collaborate effectively in teams, demonstrating leadership, interpersonal, and communication skills.
4	Evaluate results and proposed solutions considering societal, ethical, and environmental implications for sustainable development.
5	Adhere to standard engineering norms and professional practices while managing project activities
6	Engage in self-directed and lifelong learning, applying project management principles to continuous improvement and innovation.

Guidelines	
1	**Group Formation:** Students shall form project groups consisting of **three to four members**. Groups with fewer than three or more than four members will not be permitted, as the activity is designed to encourage collaborative work.
2	**Problem Identification:** Students are required to **conduct a survey** to identify relevant needs, which will be refined into a **problem statement**. This problem statement must be finalized in **consultation with the faculty supervisor, Head of Department, or an internal faculty committee**.
3	**Implementation Planning:** Each group must prepare and submit an **implementation plan** in the form of a **Gantt chart, PERT chart, or CPM chart**, outlining the **weekly schedule and milestones** of the mini project.

4	**Documentation and Logbook:** A **logbook** shall be maintained by each group to record **weekly progress**, with space for the faculty supervisor to provide **verifications/observations/comments**.
5	**Faculty Guidance:** Faculty supervisors may provide **input and guidance**, but the emphasis should remain on **self-learning and student-driven effort** throughout the project.
6	**Problem Understanding and Solution Design:** Each group is expected to **comprehend the problem thoroughly**, brainstorm and evaluate **multiple solution approaches**, and **select the most viable solution** in consultation with the faculty supervisor.
7	**Model Development and Demonstration:** The selected solution shall be developed into a **functional model** using relevant **components and techniques from the students' domain areas**, and must be **demonstrated effectively**.
8	**Validation and Reporting:** The solution must be **validated with proper justification**, and the group is required to **submit a comprehensive project report** adhering to the **standard format prescribed by the Institute**.

Project Guidance and Evaluation Framework:

- The **Head of the Department (HoD)** shall assign a **faculty guide** to each mini project and constitute a **Project Review Committee** to oversee the project activities.
- The assigned **guide will be responsible for weekly monitoring** of the group's progress and providing necessary feedback to ensure steady advancement.
- The **Project Review Committee** will conduct **at least two formal evaluations per semester**, assessing the progress through **student presentations**.
- **Assessment criteria** will include each student's **individual contribution**, **depth of understanding**, and **ability to respond effectively to questions** during evaluations.

Continuous Internal Evaluation (25 Marks)

1. Marks awarded by guide: 10 Marks *
2. Marks awarded by project review committee: 10 Marks #
3. Quality of Project report: 5 Marks

*** Marks Distribution by the Guide**	
Scope and Objective of the Project	02
Extensive Literature Survey	02
Progress of Project Work and Weekly Reporting	02
Team Work and Ethics	02
Attendance	02
Total (10)	**10**

# Project Review Marks Distribution		
Review 1	**Review 2**	**Marks**
Presentation Skills	Presentation Skills	02
Literature Review	Design methodology/ Modern tools used	02
Clarity of problem definition & feasibility	Conceptual understanding & demonstration	02
Methodology of the proposed work	Project time management	02
Usefulness to society/ Environment sustainability	Teamwork & contribution	02
Total Marks (10)	**Total Marks (10)**	**Average Marks (10)**

Oral/ Practical Exam (25 Marks)

1. Final project presentation: 15 Marks
2. Project report: 10 Marks

References for Project:

https://www.guvi.in/blog/top-mini-project-ideas-for-college-students/ https://www.geeksforgeeks.org/project-idea-college-network/?ref=ml_lbp

https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/ai-project-ideas

https://roadmap.sh/backend/project-ideas

https://webflow.com/blog/website-ideas

https://gist.github.com/MWins/41c6fec2122dd47fdfaca31924647499

https://www.projectpro.io/article/artificial-intelligence-project-ideas/461

https://github.com/The-Cool-Coders/Project-Ideas-And-Resources

https://nevonprojects.com/project-ideas/software-project-ideas/

https://roadmap.sh/projects