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

(Artificial Intelligence & Machine Learning)

CURRICULUM STRUCTURE

For

THIRD YEAR ENGINEERING

(BASED ON NEP 2020)

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

Approved by Board of Studies on 29/04/2026

Approved by Academic Council on 22/05/2026

Department of Computer Science and Engineering

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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. Chaitrali Chaudhari	**Dr. Sheeba P. S.**	**Dr. Subhash K. Shinde**
BoS Chairman, CSE (AI&ML)	**Dean,Academics & Research**	**Principal**

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

Semester		**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**
Courses										
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

Distribution of Credits:

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 than a particular program	OE	8	**08**
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

Department of Computer Science & Engineering (Artificial Intelligence & Machine Learning)

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)		
AIPCC501	Computer Network	3	-	3	-	3	20	20	60	2	-	100
AIPCC502	Artificial Intelligence	3	-	3	-	3	20	20	60	2	-	100
AIPCC503	Machine Learning & Business Intelligence	3	-	3	-	3	20	20	60	2	-	100
AIPEC501x	Program Elective Course I	3	-	3	-	3	20	20	60	2	-	100
XXMDM501	Multidisciplinary Minor course II	3	-	3	-	3	20	20	60	2	-	100
AIVSEC501	Web Design Lab	-	2*+2	-	2	2	-	50	-	-	25	75
AIPCL501	Computer Network Lab	-	2	-	1	1	-	25	-	-	25	50
AIPCL502	Artificial Intelligence and Machine Learning Lab	-	2	-	1	1	-	25	-	-	25	50
AIPEL501x	Program Elective Lab I	-	2	-	1	1	-	25	-	-	25	50
XXMDML501	Multidisciplinary Minor Lab II	-	2	-	1	1	-	25	-	-	-	25
Total		**15**	**12**	**15**	**6**	**21**	**100**	**250**	**300**	**10**	**100**	**750**

* e - learning course

AIPEC501x: Program Elective Course -1	**AIPEC5011:**Optimization Learning	**AIPEC5012:** Statistics for Artificial Intelligence & Data Science	**AIPEC5013 :** IoT and cloud Computing	**AIPEC5014:** Cyber Security
AIPEL501x: Program Elective Lab-1	**AIPEL5011** : Optimization Learning Lab	**AIPEL5012:** Statistics for Artificial Intelligence & Data Science Lab	**AIPEL5013:** IoT and cloud Computing Lab	**AIPEL5014:** Cyber Security 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)		
AIPCC601	Deep Learning	3	-	3	-	3	20	20	60	2	-	100
AIPCC602	Software Engineering and Project Management	3	-	3	-	3	20	20	60	2	-	100
AIPEC601x	Program Elective Course II	3	-	3	-	3	20	20	60	2	-	100
AIPEC602x	Program Elective Course III	3	-	3	-	3	20	20	60	2	-	100
XXMDM601	Multidisciplinary Minor course III	3	-	3	-	3	20	20	60	2	-	100
AIPCL601	Deep Learning Lab	-	2	-	1	1	-	25	-	-	25	50
AIPCL602	Software Engineering and Project Management Lab	-	2	-	1	1	-	25	-	-	25	50
AIPEL601x	Program Elective Lab II	-	2	-	1	1	-	25	-	-	-	25
XXMDML601	Multidisciplinary Minor Lab III	-	2	-	1	1	-	25	-	-	-	25
AICEP601	Mini Project II	-	2	-	1	1	-	25	-	-	25	50
Total		**15**	**10**	**15**	**5**	**20**	**100**	**225**	**300**	**10**	**75**	**700**

AIPEC601x:Program Elective Course -II	**AIPEC6011:** Cryptography and System Security	**AIPEC6012:** Natural Language Processing	**AIPEC6013:** Nature Inspired Computing	**AIPEC6014:**Augmented Reality and Virtual Reality
AIPEL601x:Program Elective Lab -II	**AIPEL6011:** Cryptography and System Security Lab	**AIPEL6012:**Natural Language Processing Lab	**AIPEL6013:** Nature Inspired Computing Lab	**AIPEL6014 :** Augmented Reality and Virtual Reality Lab
AIPEC602x: Program Elective Course -III	**AIPEC6021:** Distributed Computing	**AIPEC6022:** Data Analytics and Visualization	**AIPEC6023:** Game Theory	**AIPEC6024:**Drone Technology

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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 Lab	**MEMDML601:** Automobile 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
AIPCC501	Computer Network	20	20	60	1	2	100	

Prerequisite: Computer Organization and Architecture, Operating System	
Course Objectives: The course aims	
1	To understand the fundamental concepts of computer networks, including network devices, topologies, reference models, and Data Link Layer principles such as framing, error control, and medium access protocols.
2	To analyze Network Layer functionalities with emphasis on IP addressing, subnetting, routing algorithms, and overall packet forwarding mechanisms.
3	To describe and compare Transport and Application Layer protocols, focusing on their roles in ensuring reliable and efficient end-to-end communication.
4	To explore emerging networking approaches including Software Defined Networking, enterprise network design, network virtualization, and data centre networking concepts.
Course Outcomes: Learners will be able	
1	Demonstrate understanding of network architecture by identifying network components, topologies, reference models, and Physical Layer functionalities along with transmission media.
2	To analyze Data Link Layer mechanisms such as framing, flow control, and error control to understand reliable link-level communication.
3	To apply IP addressing, subnetting, and routing techniques for network design.
4	To demonstrate understanding of Transport and Application Layer protocols for reliable communication.
5	To design Software Defined and enterprise network architectures.
6	To explore the concepts of network virtualization and data centre networking.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Networking & Physical Layer** 1.1 Introduction to computer network, Network Devices, Network topology, Switching: Circuit-Switched Networks, Packet Switching, Network Types: LAN, MAN, WAN. 1.2 Reference models: Layer details of OSI, TCP/IP models. Difference between OSI and TCP/IP. 1.3 Physical Layer: Communication mechanisms and Electromagnetic Spectrum, Guided Transmission Media: Twisted pair, Coaxial, Fiber optics. **Self Learning Topic:** Unguided Transmission Media	6	**CO1**
02	**Data Link Layer** 2.1 Data Link Layer: DLL Design Issues (Services, Framing, Error Control, FlowControl), Error Detection and Correction (Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window (Go Back N, Selective Repeat), Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol(ALOHA, Carrier Sense Multiple Access, (CSMA/CD)). **Self Learning Topic:** Error control in wireless networks	10	**CO2**
03	**Network Layer** 3.1 Network Layer: Communication Primitives, IPv4 Addressing (classful and classless), Subnetting, IPv4 Protocol, Network Address Translation (NAT), IPv6 addressing, IPv4 vs IPv6 addressing, Routed vs Routing protocols, Classification of Routing algorithms, Shortest Path algorithms (Dijkastra s), Link state routing, Distance Vector Routing. **Self Learning Topic:** ICMP, ARP Protocol, Routing in Mobile Ad Hoc Networks (MANETs)	8	**CO3**
04	**Transport Layer and Application Layer** 4.1 Transport Layer: Service primitives, Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers, TCP Flow control (sliding Window). 4.2 Application Layer: HTTP, Telnet, FTP, IMAP ,POP3, DHCP and Types of Name Server. **Self Learning Topic:** QUIC (transport-layer network protocol), SMTP, DNS	7	**CO4**
05	**Software Defined Networks & Enterprise Network Design** 5.1 Introduction to Software Defined Network, Fundamental Characteristics of SDN, SDN Building Blocks, Control and Data planes, SDN Operation, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages. 5.2 The Cisco Service Oriented Network Architecture, Network Design Methodology, Top-Down vs Bottom up Approach to Network Design, Classic Three-Layer Hierarchical Model: Core,	5	**CO5**

	Access and Distribution Layers. **Self Learning Topic:** Designing a Campus Network Design Topology, Campus Design Considerations		
06	**Emerging Networking Technologies** 6.1 Concept of Network Virtualization and its importance, Virtual LAN (VLAN) and Virtual Private Network (VPN). 6.2 Data Centre Networking: Introduction, Design goals, Importance of DCN, Traffic Patterns in Data Centers,Network Topology in Data Centers:Clos Topology (Fabric Architecture). **Self Learning Topic:** Implementing VLAN/VPN in virtualized network scenarios, Role of DCN in virtualization, cloud computing, and big data.	6	**CO6**

Text Books:

1. A.S. Tanenbaum, Computer Networks,4 th edition Pearson Education.
2. B.A. Forouzan, Data Communications and Networking, 5 th edition, TMH
3. Diane Teare , Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press.
4. Paul Göransson, Chuck Black, Software Defined Networks: A Comprehensive Approach, MK Publication.
5. Gonzalo Camarillo and Miguel A. García-Martín, Virtual Private Networks: Technologies and Solutions, Addison-Wesley, 2012.

References:

1. Natalia Olifer & Victor Olifer,Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.
2. Cloud Networking: Understanding Cloud-based Data Centre Networks, Gary Lee (Author), Morgan Kaufmann (Publisher), 2014,ISBN-139780128007280

Online References:

1. NPTEL: Prof. Neminath Hubballi & Prof. Sameer G Kulkarni IIT Gandhi nagar https://onlinecourses.nptel.ac.in/noc23_cs35/preview
2. NPTEL: Prof. Soumya Kanti Ghosh & Prof. Sandip Chakraborty IIT Kharagpur https://nptel.ac.in/courses/106105183
3. https://www.coursera.org/specializations/computer-communications

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
AIPCC502	Artificial Intelligence	20	20	60	1	2	100	

Prerequisite: Discrete Mathematics, Data Structures and Algorithms	
Course Objectives: The course aims to	
1	Gain perspective of AI and its foundations.
2	Study different agent architectures and properties of the environment.
3	Understand the basic principles of AI towards problem solving, inference, perception,knowledge representation, and learning.
4	Investigate probabilistic reasoning under uncertain and incomplete information.
5	Explore the current scope, potential, limitations, and implications of intelligent systems.
Course Outcomes: Learners will be able to	
1	Identify the characteristics of the environment and differentiate between various agent architectures.
2	Apply the most suitable search strategy to design problem-solving agents.
3	Represent a natural language description of statements in logic and apply the inference rules to design knowledge-based agents.
4	Apply a probabilistic model for reasoning under uncertainty.
5	Comprehend various learning techniques and describe the various building blocks of an expert system for a given real word problem.
6	Interpret various components and various types of Autoencoders. Also to Understand various aspects of Transfer Learning.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Artificial Intelligence and Intelligent Agents**	6	CO1
	1.1 Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally		
	1.2 History of AI, Applications of AI, The present state of AI, Ethics in AI.		
	1.3 Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents		
	1.4 Types of Agents: Simple Reflex, Model Based, Goal Based and Utility Based Agents.		

	Self-Learning Topic: Understanding of PEAS description and task environment for specific AI problems, Design and Implementation of Intelligent Agents in Real-World Environments.		
02	**Solving Problems by Searching**	9	**CO2**
	2.1 Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems		
	2.2 Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality		
	2.3 **Uninformed Search:** Depth-First Search, Breadth First Search, Depth-Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search		
	2.4 **Informed Search:** Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search, Optimization: Genetic Algorithm		
	2.5 Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning		
	Self-Learning Topic: Implementation and Comparative Analysis of Search Algorithms for Problem Solving		
03	**Knowledge and Reasoning**	9	**CO3**
	3.1 Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems		
	3.2 **Propositional Logic (PL):** Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula, Introduction to logic programming (PROLOG)		
	3.3 **Predicate Logic:** FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL,		
	3.4 Forward Chaining, Backward Chaining and Resolution in FOPL		
	Self-Learning Topic: Building and Querying Knowledge Graphs for Intelligent Information Retrieval, Case-Based Reasoning System for Automated Decision Support		
04	**Reasoning Under Uncertainty and Planning**	6	**CO4**
	4.1 Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution		
	4.2 Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks		
	4.3 The planning problem, Partial order planning, total order planning		
	Self Learning Topic: Simulate a coin toss and dice roll in Python to compute joint and conditional probabilities,Create a simple weather prediction model using prior and posterior probabilities.		
05	**Learning and Expert System**	6	**CO5**
	5.1 Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.		

	5.2 Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems.		
	5.3 Overview of generative models and their importance in AI, Fundamentals of Probability theory and generative modeling, Introduction to GANs, VAEs and other generative models.		
	Self Learning Topic: Implement a simple forward chaining and backward chaining inference system.		
06	**Variational Autoencoders**	6	**CO6**
	6.1 Introduction and Basic components of Variational Autoencoders(VAEs).Types of Autoencoders:Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders, Variational Autoencoders (for generative modelling)		
	6.2 Transfer Learning: Basic terminologies, Pre-trained model and data sets, Feature extraction and fine tune transfer learning , Recent advancement in transfer learning : self- supervised learning and meta learning.		
	Self Learning Topic: Build a rule-based medical or crop diagnosis system using Python or CLIPS		

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach —Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight —Artificial Intelligencel Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.

References:

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3. Saroj Kaushik "Artificial Intelligence", Cengage Learning.
4. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
6. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Online References:

1. NPTEL: Prof. V. Susheela Devi, IISc Bangalore, nptel.ac.in/courses/106108705

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
AIPCC503	Machine Learning & Business Intelligence	20	20	60	1	2	100	

Prerequisite: Mathematics for Computer Science, Data Structures and Algorithms	
Course Objectives: The course aims to	
1	Introduce the fundamentals of Business Intelligence and machine learning concepts and their applications
2	Apply mathematical and statistical foundations required for understanding and implementing ML models
3	Perform preprocessing and dimensionality reduction techniques for effective learning
4	Study various Classification and Regression techniques
5	Apply unsupervised learning methods for pattern discovery.
6	Introduce association rule mining techniques for discovering relationships among business variables
Course Outcomes: Learners will be able to	
1	Explain the basic concepts of machine learning and their relation to Business Intelligence
2	Apply Mathematical concepts to support machine learning computation
3	Perform preprocessing and apply dimensionality reduction techniques.
4	Build and evaluate various classification and regression models for predictive business analytics.
5	Apply clustering models to group and analyze business data for decision making
6	Generate and interpret association rules to extract actionable insight from transactional datasets

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Machine Learning and Business Intelligence**	5	CO1
	1.1 Introduction to business intelligence. Components of BI. Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.		
	1.2 Supervised and Unsupervised Learning, Training, Testing and validation dataset, cross validation, overfitting and underfitting of model.		

	Self Learning Topic: Semi supervised learning, Training and testing error		
02	**Mathematical Foundation for ML**	7	**CO2**
	2.1 Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors		
	2.2 Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications		
	2.3 Descriptive statistics(mean,variance,standard deviation)		
	Self Learning Topic: Probability basics.		
03	**Preprocessing & Dimensionality Reduction**	7	**CO3**
	3.1 Knowledge discovery process,Data exploration:Types of attributes , Data preprocessing- Data Cleaning; Data Integration; Data Reduction: Attribute subset selection,Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis.		
	3.2.Curse of Dimensionality,Feature Selection and Feature Extraction, Dimensionality Reduction Techniques, Principal Component Analysis.		
	Self Learning Topic: Introduction to data visualization		
04	**Regression and Classification Models**	8	**CO4**
	4.1 Simple linear regression, Multiple linear regression, Logistic regression		
	4.2 Classification methods: Decision Tree Induction: Attribute Selection Measures, Bayesian Classification: Naïve Bayes Classifier, KNN, Support Vector Machines		
	4.3 Performance Measures: Measuring Quality of model- Confusion Matrix,Accuracy, Recall, Precision, Specificity, F1 Score		
	Self Learning Topic: Least square regression for classification, Tree pruning		
05	**Clustering and Association Rule**	8	**CO5**
	5.1 Partitioning clustering Method: K-Means Hierarchical Methods: Agglomerative, Divisive,Expectation -Maximization algorithm		
	5.2 Frequent Itemsets, Closed Itemsets, and Association Rules; Frequent Pattern Mining, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation.		
	5.3 What are outliers? Types, Challenges.		
	Self Learning Topic: Case study on customer segmentation using clustering models. Association rule analysis for customer insight in the banking sector.		
06	**Ensemble learning**	7	**CO6**
	6.1 Introduction to Ensemble Methods. Bagging and random forests, Boosting algorithms : AdaBoost Stacking and blending models, Extreme Gradient Boosting (XGBoost): XGBoost Regression and classification.		
	Self Learning Topic: Case Study on Predicting Customer Churn in Telecom Using Ensemble Learning Techniques		

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition
2. Ralph Kimball, Margy Ross, The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling‖, 3rd Edition. Wiley India.
3. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, Mathematics for machine learning,
4. Ethem Alpaydın, Introduction to Machine Learning‖, MIT Press McGraw-Hill Higher Education

References:

1. Tom M. Mitchell, Machine Learning, McGraw Hill
2. Kevin P. Murphy, Machine Learning ― A Probabilistic Perspective, MIT Press
3. Stephen Marsland, Machine Learning an Algorithmic Perspective, CRC Press
4. Shai Shalev-Shwartz, Shai Ben-David, ―Understanding Machine Learning, Cambridge University Press
5. Peter Harrington, Machine Learning in Action‖, DreamTech Press
6. NPTEL: By Prof. Anubha Gupta IIIT Delhi

https://www.youtube.com/watch?v=O9Tjcc0Dm-E&list=PLd0IBaoJIlclq5feecmIC5RpjyIyDZxiX

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
AIPEC 5011	**Optimization Learning**	20	20	60	1	2	100	

Prerequisite: Data Structures, Analysis of Algorithm,Discrete Mathematics	
Course Objectives: The course aims to	
1	To build a strong foundation in computational complexity and optimization-oriented algorithm design.
2	To apply Approximation, Randomized, and Local Search methods for solving complex optimization problems.
3	To understand and analyze String Algorithms and Amortized Analysis to improve algorithmic efficiency.
4	To explore Combinatorial optimization techniques for real-world AI/ML and engineering applications.
Course Outcomes: Learners will be able to	
1	Analyze concepts of P, NP, NP-Hard and NP-Complete problems
2	Apply and analyze Approximation Algorithms for NP-Hard problems
3	Apply Randomized Algorithms and evaluate their complexity
4	Apply Local Search and Meta-heuristic techniques for optimization
5	Apply String Matching and Amortized Analysis concepts
6	Apply Combinatorial Optimization techniques to problem solving

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundations of Optimization and Complexity**	08	**CO1**
	Classes P & NP, NP-Hard, NP-Complete, Polynomial-time reductions Cook-Levin theorem, Classic NP-Complete problems: SAT, 3-SAT, Clique, Vertex-Cover, Set Cover, Hamiltonian Cycle, Partitioning Problems,Proof strategies for NP-Completeness, Co-NP and Hardness Taxonomy		
	Self Learning Topic: Subset Sum variations, Independent Set, Dominating Set		
02	**Approximation-Based Optimization**	09	**CO2**
	Approximation concepts, Approximation ratios and performance guarantees, Polynomial Time Approximation Scheme (PTAS) & FPTAS, Greedy Approximation for Set Cover, Vertex-Cover 2-Approximation, Approximation for Bin Packing (First-Fit, Best-Fit, Next-Fit), Edge Coloring Approximation, Randomized Rounding using Linear		

	Programming, Inapproximability and limits of optimization		
	Self Learning Topic: PTAS for TSP		
03	**Randomized Algorithms**	09	**CO3**
	Introduction, Role of randomness in algorithm design, Randomized Min-Cut, Randomized Divide-and-Conquer (Quick sort), Randomized Hashing & Dictionaries, MAX 3-SAT randomized approximation, Chernoff Bounds – tail probability control, Load Balancing and Randomized Packet Routing, Monte-Carlo and Las-Vegas methods		
	Self Learning Topic: Karger's Min-Cut variations		
04	**Local Search & Meta-Heuristics**	06	**CO4**
	Optimization landscape and neighborhoods, Hill Climbing and local maxima problem, Simulated Annealing and Metropolis Algorithm, Local Search for Max-Cut, Local Search in Classification problems, Best-Response Dynamics, Nash Equilibrium intuition, Tabu Search		
	Self Learning Topic: Genetic Algorithm basics		
05	**Optimized String Algorithms & Amortized Analysis**	05	**CO5**
	Tries and string sorting; substring search problem; optimized string-matching algorithms: Aho–Corasick, Z-Algorithm, amortized analysis – aggregate, accounting, and potential methods; dynamic tables and amortized cost		
	Self Learning Topic: Applications in text processing and data compression		
06	**Combinatorial Optimization**	05	**CO6**
	Combinatorial optimization overview; combinatorics and optimization principles; generation of next subset of n-set; random subset selection methods; sequencing and ranking problems; selection in combinatorial families (Knapsack, Subset-Sum); heuristic and meta-heuristic approaches (Greedy, Genetic Algorithms)		
	Self Learning Topic: Applications in AI such as feature selection and routing.		

Text Books:

1. Jon Kleinberg, Eva Tardos," Algorithm Design", Pearson
2. Thomas H. Cormen et al., "Introduction to Algorithms" , MIT Press
3. Robert Sedgewick, Kevin Wayne, "Algorithms", Addison-Wesley
4. Vijay V. Vazirani, "Approximation Algorithms", Springer, 2001.
5. Albert Nijenhuis, Herbert Wilf, "Combinatorial Algorithms for computers and calculators" ,Second edition, Academic Press

References:

1. Anany Levitin, "Intro to Design & Analysis of Algorithms".
2. Gusfield, D., Algorithms on Strings, Trees, and Sequences, Cambridge University Press.
3. NPTEL: By Prof. Madhavan Mukund Chennai Mathematical Institute

https://www.youtube.com/playlist?list=PLEAYkSg4uSQ1YxqcmBjCdK9oX1m-JDEx2

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
AIPEC 5012	**Statistics for Artificial Intelligence & Data Science**	20	20	60	1	2	100	

Prerequisite: Mathematical Knowledge, Computing and Programming Skills	
Course Objectives: The course aims to	
1	Provide a foundation in descriptive, inferential, and predictive statistical concepts essential for AI and data science.
2	Enable learners to explore, summarize, and visualize data for insight generation and model preparation.
3	Develop the ability to perform hypothesis testing, regression, and variance analysis for data-driven decision-making.
4	Apply statistical inference techniques and model evaluation methods to real-world AI/ML problems using modern tools.
Course Outcomes: Learners will be able to	
1	Perform exploratory data analysis (EDA) and summarize datasets using statistical measures and visualizations.
2	Apply probability and sampling distributions to quantify uncertainty and analyze random phenomena.
3	Conduct hypothesis testing and experimental design to validate assumptions and support decision-making.
4	Build and evaluate regression models to analyze relationships and predict outcomes from data.
5	Implement ANOVA and non-parametric tests such as Kruskal–Wallis and Friedman's tests for group comparisons.
6	Utilize applied statistical inference methods such as bias–variance tradeoff, cross-validation, and Bayesian updating for AI/ML applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Exploratory Data Analysis (EDA)**	6	CO1
	Elements of structured data, Estimates of Location (Mean, Weighted Mean, Trimmed Mean, Median, Weighted Median, Robust, Outlier), Estimates of Variability (Deviation, Absolute Deviation, Variance, Standard Deviation, Range, Order Statistics, Percentile, IQR), Exploring the Data Distribution (Box plot, Frequency Table, Histogram, Density plot), Mode, Expected Value, Correlation Coefficient, Scatterplots, Exploring two or more variables (Contingency Tables, Hexagonal Binning, Contour Plots, Violin Plots).		
	Self Learning Topic: Perform EDA using Python on real-world datasets.		
02	**Probability & Sampling Distributions**	7	CO2
	Random Sampling and Sampling Bias, Random Selection and Selection Bias, Normal Distribution, Central Limit Theorem, Standard Error, Confidence Interval, The Bootstrap, QQ Plots, Long-tailed distributions, Student's t-distribution, Binomial Distribution, Poisson Distribution, Chi-square Distribution, Weibull Distribution.		
	Self Learning Topic: Implement bootstrapping and sampling using Python.		
03	**Hypothesis Testing and Experimental Design**	8	CO3
	A/B Testing, Hypothesis Test, Null and Alternative Hypothesis, One way vs Two Way Hypothesis Test, Permutation Test (Exhaustive, Bootstrap), statistical significance, p-value, alpha, Type 1 and Type 2 Errors, Degrees of Freedom, t-test, Fisher's Exact Test, Multi-Arm Bandit algorithm.		
	Self Learning Topic: Perform A/B testing using Python or R.		
04	**Regression and Correlation**	8	CO4
	Feature Engineering (Feature scaling, Normalization, Standardization), Handling categorical variables, Residual analysis, Multicollinearity, K-Fold Cross Validation, Ridge & Lasso regularization, Model fit and error metrics (R^2, RMSE).		
	Self Learning Topic: Create regression models using scikit-learn.		
05	**The Analysis of Variance**	6	CO5
	One-Way Layout, One-Way ANOVA, Two-Way Layout, Two-Way ANOVA, F test, Randomized Block Design, Additive Parametrization, The Kruskal-Wallis Test, Friedman's Test, Principal Component Analysis (PCA).		
	Self Learning Topic:		

	Perform PCA on real datasets using Python.		
06	**Applied Statistical Inference for AI/ML**	7	**CO6**
	Bias-variance tradeoff, Cross-validation, Statistical interpretation of ML results, Bayesian updating, Case studies in AI applications (model fairness, bias detection, A/B testing).		
	Self Learning Topic: Perform bias-variance evaluation of an ML model.		

Text Books:

1. Bruce, Peter & Bruce, Andrew. *Practical Statistics for Data Scientists: 50 Essential Concepts*, O'Reilly Media, 2nd Edition.
2. Montgomery, Douglas C. & Runger, George C. *Applied Statistics and Probability for Engineers*, Wiley, 7th Edition.
3. Rice, John A. *Mathematical Statistics and Data Analysis*, Cengage Learning, 3rd Edition.
4. *An Introduction to Statistical Learning*, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani

References:

1. Field, Andy. *Discovering Statistics Using R*, Sage Publications, 2016.
2. Imsay, Chester & Kim, Albert Y. *Statistical Inference via Data Science: A Modern Dive into R and the Tidyverse*, CRC Press, 2020.
3. Johnson, R.A. & Gupta, C.B. *Miller and Freund's Probability and Statistics for Engineers*, Pearson, 7th Edition.
4. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow.

Online References:

1. https://nptel.ac.in/courses/106106212
2. https://nptel.ac.in/courses/111106112
3. https://nptel.ac.in/courses/111102112

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
AIPEC 5013	**IoT and Cloud Computing**	20	20	60	1	2	100	

Prerequisite:Computer Fundamentals and Networking	
Course Objectives: The course aims to	
1	Introduce the fundamental concepts, architecture, and characteristics of the Internet of Things (IoT).
2	Explain various IoT network architectures, communication models, and data management frameworks.
3	Familiarize learners with IoT communication protocols and connectivity technologies
4	Describe the principles, architecture, and service models of cloud computing.
5	Explain virtualization techniques, hypervisors, and modern cloud infrastructure components.
6	Develop understanding of security, privacy, and governance issues in IoT and cloud environments.
Course Outcomes: Learners will be able to	
1	Define and explain IoT concepts, architecture, and applications across multiple domains.
2	Analyze IoT network architectures, data management models, and edge–fog–cloud integration.
3	Compare and evaluate IoT communication protocols and technologies for different applications.
4	Demonstrate understanding of cloud computing fundamentals, deployment models, and service models.
5	Explain virtualization mechanisms, hypervisors, and resource management in cloud environments.
6	Assess security, privacy, and governance challenges in IoT and cloud platforms and recommend suitable solutions.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Internet of Things (IoT)** IoT Overview: Concept, Definition, and Characteristics; IoT Conceptual Framework; Physical Design of IoT: Sensors, Actuators, Devices, Gateways, and Network Infrastructure; Logical Design: Functional Blocks and Layers; Smart Objects: Definition and Features; Applications of IoT in Smart Cities, Healthcare, Agriculture, and	7	**CO1**

	Industry; Case Discussion and Recent Trends in Smart Environments.		
	Self Learning Topic: IoT Standards and Frameworks (IEEE, ITU-T, ISO).		
02	**IoT Network Architectures and Data Management**	7	**CO2**
	Drivers for IoT Architectures: Scale, Security, Data, and Legacy Support; IoT Reference Models – IoT World Forum (IoTWF); Simplified IoT Architecture and Core Functional Stack (Layers 1–3); IT and OT Responsibilities; Data Management and Smart Services in IoT; Compute Stack – Fog, Edge, and Cloud Hierarchy; Integration of Edge, Fog, and Cloud Computing with Use Cases.		
	Self Learning Topic: IoT Data Pipeline and Data Lifecycle Management.		
03	**IoT Communication Protocols and Technologies**	8	**CO3**
	Introduction to IoT Communication Requirements; RFID and Near-Field Communication (NFC); Bluetooth Low Energy (BLE) and Li-Fi Overview; WPAN Standards – IEEE 802.15 (Bluetooth, Zigbee, Z-Wave); Narrow Band IoT (NB-IoT) and Cellular LTE/LTE-A; Internet Protocol Suite – TCP/IP and 6LoWPAN; Long-Range Communication – LoRa and LoRaWAN; Application Protocols – HTTP, MQTT, and CoAP with Comparative Case Study.		
	Self Learning Topic: Comparison of MQTT and CoAP for Smart Agriculture.		
04	**Fundamentals of Cloud Computing**	6	**CO4**
	Introduction and Evolution of Cloud Computing; NIST Definition and Cloud Cube Model; Key Characteristics: On-Demand Service, Elasticity, Broad Access, and Measured Service; Cloud Deployment Models: Public, Private, Hybrid, and Community; Service Models: IaaS, PaaS, and SaaS with Examples; Advantages and Challenges of Cloud Adoption.		
	Self-Learning Topic: Overview of Major Cloud Providers (AWS, Azure, GCP).		
05	**Virtualization and Cloud Infrastructure**	7	**CO5**
	Concept and Need for Virtualization; Types and Mechanisms of Virtualization; Hypervisors – Bare-Metal and Hosted; Virtual Machines and Containers; Cloud Infrastructure Components and Resource Management; Introduction to Serverless Computing; Overview of Microservices Architecture.		
	Self-Learning Topic: Containerization using Docker and Basics of Kubernetes.		
06	**Security, Privacy, and Governance in IoT and Cloud**	7	**CO6**
	Introduction to Security, Privacy, and Governance in IoT and Cloud; Privacy Concerns and Data Protection Mechanisms; IoT Security Challenges in Devices, Networks, and Platforms; Secure Platforms for Smart Cities; Cloud Security Fundamentals – Authentication, Encryption, and Access Control; Governance and Compliance – GDPR, HIPAA, and Industry Standards; Case Study on Cloud Security		

	Breaches and Mitigation.		
	Self Learning Topic: Real-World Cloud Security Breach Case Studies (AWS, Azure, GCP).		

Text Books:

1. Arsheep Bahga, 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.
3. Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices. AndrewMinteer,Packet
4. Giacomo Veneri , Antonio Capasso,Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Packt
5. Shailendra Singh, *Cloud Computing*, First Edition, Oxford University Press, India, 2018.
6. Thomas Erl, *Cloud Computing: Concepts, Technology & Architecture*, First Edition, Prentice Hall/Pearson Education, 2013.

References:

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
6. Ian Foster and Dennis B. Gannon, *Cloud Computing for Science and Engineering*, First Edition, The MIT Press, 2017.

Online References:

1. NPTEL: Sudip Misra, IIT Kharagpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106105166
2. NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://nptel.ac.in/courses/108108179

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
AIPEC 5014	Cyber Security	20	20	60	1	2	100	

Prerequisite: Networking Fundamentals	
Course Objectives: The course aims	
1	To understand the fundamental concepts of cybersecurity, cybercrime, information security principles, and the importance of maintaining privacy.
2	To identify and analyze various types of cyber threats, attacks, vulnerabilities, and the corresponding network security measures required to mitigate them.
3	To comprehend the techniques and role of ethical hacking, digital forensics, and security challenges associated with mobile and wireless environments.
4	To understand the basics of cryptography and gain awareness of cybersecurity standards, frameworks, and governance practices essential for securing organizational systems.
Course Outcomes: Learners will be able to	
1	Define cybersecurity, cybercrime, and explain the CIA triad and its importance in protecting information assets.
2	Recognize and categorize various malware, social engineering attacks, and network-based threats; describe network security protocols and defense mechanisms.
3	Explain ethical hacking concepts, penetration testing phases, and conduct basic digital forensic procedures including evidence handling.
4	Identify vulnerabilities in mobile and wireless environments, understand associated attack vectors, and assess organizational security policies for mobile computing.
5	Apply fundamental cryptographic techniques including symmetric and asymmetric encryption, and evaluate privacy concerns and regulations.
6	Explain, compare, and apply major cybersecurity standards and frameworks, and develop basic security governance documentation including policies, standards, and procedures aligned with organizational and regulatory compliance requirements.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction To Cybersecurity** Cybersecurity Definition,Cybercrime definition and origins of the world,Cybercrime and information security, Classification of Cybercrime, CIA Triad: Confidentiality, Integrity,	06	CO1

	Availability,Threats, Vulnerabilities, Risks, and attack surfaces, Case study: Real-world cyberattack overview. **Self Learning Topic:** Importance of Cyber security in today's world.		
02	**Types Of Cyber Threats , Attacks And Network Security** Malware: viruses, worms, Trojans, ransomware, spyware, Phishing, social engineering, identity theft,Denial of Service (DoS), DDoS,Man-in-the-Middle (MitM), DNS spoofing, ARP poisoning,Advanced Persistent Threats (APT). Network architecture and protocols overview (TCP/IP, DNS),Firewalls, IDS/IPS, VPNs,Network scanning and monitoring,Wi-Fi security (WEP, WPA, WPA2, WPA3). **Self Learning Topic:** Authentication and Access control.	10	**CO2**
03	**Ethical Hacking And Cyber Forensics** Understanding Ethical Hacking Terminology , Identifying Different Types of Hacking Technologies,Role of ethical hackers, Phases of penetration testing,Digital forensics basics: evidence collection, chain of custody. Case study: Forensic analysis of a breach. **Self Learning Topic:** Forensics Process and methodology .	06	**CO3**
04	**Cybercrime: Mobile And Wireless Devices** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Case study: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket. **Self Learning Topics:** E-mail spoofing instances.	09	**CO4**
05	**Cryptography Basics And Information Privacy** Basics of Cryptography, Symmetric Key Encryption-DES,Substitution Ciphers(monoalphabetic Caesar cipher),Foundations of privacy - Information privacy, Measurement, Theories, Privacy regulation - Privacy, Anonymity, Regulation, Data Breach. **Self Learning Topic:** Cryptography Hash functions.	06	**CO5**
06	**Cyber Security Standards** Need for cybersecurity standards and frameworks, Relationship between policy, standard, and procedure,Security Standards ISO/IEC 27001 & 27002,Payment Card Industry Data Security Standard (PCI DSS),NIST Cybersecurity Framework (CSF),FISMA (Federal Information Security Management Act),SOC2. **Self Learning Topics:**IT Act 2000 and amendments (Cyber laws).	05	**CO6**

Text Books:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.
2. CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007.
3. William Stallings, Cryptography and Network Security, Pearson Publication
4. "Digital Forensics with Kali Linux" — Shiva V. N Parasram.
5. Introduction to Modern Cryptography by Jonathan Katz & Yehuda Lindell,ISBN-13: 978-1-4665-7027-6
6. Cybersecurity Frameworks and standards by Mark Hayward.

References:

1. https://uou.ac.in/sites/default/files/slm/Introduction-cyber-security.pdf.
2. Cyber Security Essentials, James Graham, Richard Howard and Ryan CRCPress.
3. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&FGroup.
4. https://www.youtube.com/playlist?list=PLyqSpQzTE6M-jkJEzbS5oHJUp2GWPsq6e

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
CEMDM 501	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 the 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**	4	CO1
	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, three tier database architecture, Data independence		
02	**Data Models**	3	CO2
	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		
03	**Database Design, ER-Diagram and Unified Modelling Language**	10	CO3
	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		

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. 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
ETMDM 501	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	Analyze 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 .
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	08	**CO6**

	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		

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
ARMDM 501	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. Definition, scope and evolution of Mechatronics, Key elements of Mechatronic system (mechanical structure, sensors, actuators, electronics, control unit, software), 2. Integrated design approach in Mechatronics vs conventional design, Mechatronics design process (problem identification, modelling,	05	CO1

	simulation, prototyping, implementation) **Self-Learning Topic:** Real-life mechatronic system identification (elevator, printer, washing machine, etc.		
02	**Selection of Sensors & Actuators** 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. 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	**07**	**CO2**
03	**Data Acquisition, Signal Conditioning & Microcontroller System Theory** 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 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	**07**	**CO3**
04	**Design of Pneumatic & Hydraulic Circuits** 1. Design of Pneumatic Sequencing Circuits using the Cascade method and the shift register method (up to 2 cylinders) 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	**08**	**CO4**
05	**Design of Electro-pneumatic Circuits** 1. Electro-pneumatic Circuits Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves, with and without grouping. 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	**08**	**CO5**
06	**Reliability, communication, and Case studies** 1. Reliability, maintainability, safety, and fault diagnosis in mechatronic	**07**	**CO6**

	systems 2. Communication Protocols (overview only), CAN, UART, SPI, I2C (basics only) 3. Case Studies: Automotive ABS, CNC feed drive system, Pick & place robot, Smart manufacturing cell		

Text Books:

- Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
- Mechatronics System Design, Shetty and Kolk, Cengage Learning, India Edition
- Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
- Pneumatic Circuits and Low-Cost Automation by Fawcett JR
- Electromechanical Design Handbook, Walsh, McGraw-Hill
- Electro-mechanical Engineering - An Integrated Approach, Fraser and Milne
- 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:

1.1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
1.2. 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	08	CO1

	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		
02	**Micro and MEMS Sensors for IoT:**	**06**	**CO2**
	2.1 Introduction to MEMS and micro-sensors. **2.2** MEMS fabrication techniques (lithography, etching, deposition, packaging) **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: ● DC motor, stepper motor, servo motor ● Control techniques (PWM, H-bridge) Pneumatic and hydraulic actuators – basic operation and control valves. Mechanical actuators- operation and types and control circuit. Smart actuators and drive circuits for IoT. Thermal actuators- basic operation and control circuit. Magnetic actuator-basic operation and control circuit **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). **Self -Learning Topic: Case Studies:** Smart agricultural sensing system and IoT-enabled vibration and air-quality transducer networks.	**07**	**CO6**

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
MEMDM 501	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	06	CO3

	Self-Learning Topic: Nuclear Materials		
04	**Module Title:** 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** Mini & Micro Hydro Electric Plants, Application & Site Selection. Hybrid Energy, Economic Environmental & Regulatory Aspects of Renewable Sources. **Self-Learning Topic: Hydrology**	06	**CO6**

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
EEMDM 501	Special Machines and smart grid	20	20	60	1	2	100	

Prerequisite: Basic Electrical Engineering, Electric Machine	
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:** 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	07	CO1

02	**Switched Reluctance Motors (SRM)** 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	**07**	**CO2**
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.
   E. G. Janardanan, *Special Electrical Machines*, PHI Learning.
   Microgrids architectures and control Edited by Nikos Hatziargyriou, Wiley, IEEE Press, 2014.
2. A. Keyhani, M. N. Marwali, M. Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, 2009.
3. Antonio Carlos Zambroni de Souza, Miguel Castilla, Microgrids Design and Implementation,Springer 2019.

4. James Momoh, ―Smart Grid: Fundamentals of Design and Analysis,‖ IEEE Press and Wiley Publications, 2015.
5. 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)

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						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2*+2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
AIVSEC 501	**Web Design Lab**	-	50	25	-	-	75	

* e-learning

Prerequisite: OOPs, DBMS	
Course Objectives: The lab course aims to	
1	Understand the fundamentals of web technologies including the working of web browsers, HTTP/HTTPS protocols, and the client–server request–response cycle.
2	Design and develop structured and responsive web pages using HTML5, CSS3, and modern layout techniques such as Flexbox, Grid, and Bootstrap.
3	Implement interactivity and dynamic behavior in web pages using JavaScript, ES6 features, and the Fetch API for asynchronous data handling.
4	Gain hands-on experience in developing front-end applications using modern frameworks like React and Angular, focusing on components, state management, and routing.
5	Understand server-side programming concepts and develop RESTful APIs using Node.js and the Express framework.
6	Integrate and manage databases in web applications by connecting Node.js with MySQL to perform CRUD operations and build full-stack applications, including SSR with Next.js.
Course Outcomes: Learners will be able	
1	Demonstrate an understanding of web architecture and protocols by analyzing the request–response mechanism using browser developer tools.
2	Design and develop semantic, accessible, and responsive web pages using HTML5, CSS3, and Bootstrap grid systems.
3	Implement interactive and data-driven web functionality using JavaScript, ES6 syntax, and Fetch API for asynchronous communication.
4	Build reusable, modular, and efficient front-end applications using React components, props, state, and hooks for dynamic rendering.
5	Develop RESTful services and backend logic using Node.js and Express to handle client requests and integrate with databases.
6	Design, deploy, and maintain full-stack web applications that connect front-end frameworks with backend APIs and databases, applying SSR and modern styling techniques through Next.js and Tailwind CSS.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of Web Browser, HTTP/HTTPS Protocols, and Request–Response Cycle using Developer Tools	1
02	Select a project and design Structured Web Pages using HTML5 Tags, Forms, Tables, and Multimedia	2
03	Create a Responsive Web Layout using CSS3 Flexbox and Grid for the selected project	2
04	Develop a Mobile-friendly Web Page using Bootstrap Components and Grid System for the selected project	2
05	Implement Form Validation and Dynamic Content using JavaScript for the selected project	3
06	Demonstrate ES6 Features and Fetch API for Data Retrieval for the selected project	3
07	Develop a React Application using Components, Props, and State for the selected project	4
08	Implement React Hooks (useState, useEffect) and Conditional Rendering for the selected project	4
09	Create a RESTful API using Node.js and Express Framework for the selected project	5
10	Connect Node.js Application with MySQL Database to Perform CRUD Operations for the selected project	5
11	Develop a Single Page Application using Angular Components, Services, and Routing for the selected project	6
12	Build a Next.js Application Implementing SSR, Routing, and Tailwind CSS Styling for the selected project	6

Text Books:

1. HTML & CSS: Design and Build Web Sites, Jon Duckett,, First Edition, 2011, Wiley.
2. HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery) 2Ed., DT Editorial Services, Second Edition, 2016, Dreamtech Press.
3. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, First Edition, 2017, Shroff/O'Reilly O'Reilly
4. Learning Node.js Development, Andrew Mead, Kindle Edition, 2018, Packet Publishing

Reference Books:

1. JavaScript & jQuery: Interactive Front-End Development, Jon Duckett, First edition, 2014, Wiley
2. Full Stack Web Development For Beginners, Riaz Ahmed, 2021
3. Beginning Node.js, Express & MongoDB Development, Greg Lim, 2020
4. Full-Stack React Projects: Modern web development using React 16, Node, Express, and MongoDB, Shama Hoque, First edition, 2018, Packt Publication

Other Resources:

1. JavaScript Tutorial Web link: https://www.w3schools.com/js/
2. React: The library for web and native user interfaces Web link: https://react.dev/
3. Deliver web apps with confidence Web link: https://angular.io/
4. Run JavaScript Everywhere Web link: https://nodejs.org/en
5. Express4.18.3 Fast, unopinionated, minimalist web framework for Node.js Web link: https://expressjs.com/

Continuous Internal Evaluation (50 Marks)

1. Lab Performance: 10 Marks
2. Presentation: 10 Marks
3. Online Certification or Skill Based Project[$] : 25
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, Learners 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 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
AIPCL501	Computer Network Lab	-	25	25	-	-	50	

Prerequisite: Programming Knowledge	
Course Objectives: The lab course aims to	
1	To understand and analyze various network devices, topologies, protocols, and Linux networking commands for configuration and troubleshooting.
2	To implement client–server communication using socket programming with TCP, UDP.
3	To design, configure, and simulate routing, VLAN, and NAT-enabled networks using tools such as Packet Tracer and NS3.
4	To understand and apply network configuration, routing, and packet filtering using NS3, and to evaluate network performance and protocol behavior using Wireshark and Mininet.
Course Outcomes: On successful completion of lab course, learner will be able to	
1	Design various network topologies using Cisco Packet Tracer.
2	Use and interpret basic Linux networking commands for network setup, monitoring, and troubleshooting.
3	Implement error detection and correction techniques, including Hamming Code and Cyclic Redundancy Check (CRC), using an appropriate programming language.
4	Design, configure, and verify routing, VLAN, and NAT configurations in simulated environments.
5	Develop and execute socket programs for reliable (TCP) and connectionless (UDP) communication.
6	Configure NS3 topologies, manage routing and packet filtering in Linux, and evaluate network performance and protocol behavior using Wireshark and Mininet.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To design and simulate Star /Bus topology using Cisco Packet Tracer.	1
02	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP,RARP, ip, ifconfig, dig, route).	2
03	To implement Hamming code for error detection and Error correction using any Programming Language.	3
04	To Implement CRC (Cyclic Redundancy Check) using any programming language.	3
05	To design and simulate the environment for Dynamic routing using Cisco Packet Tracer.	4
06	To design and Simulate NAT on the router using Cisco packet tracer.	4

07	Implementation of socket programming to enable communication over TCP or UDP protocols.	5
08	To design and simulate VLANs on the switch/router using Cisco packet tracer.	4
09	Study and Installation of Network Simulator (NS3)	6
10	Implement the following using Network Simulator (NS3). a. Set up multiple IP addresses on a single LAN. b. Using netstat and route commands of Linux, do the following: ● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IP tables in Linux.	6
11	Use Wireshark to understand the operation of TCP/IP layers: ● Ethernet Layer: Frame header, Frame size etc. ● Data Link Layer: MAC address, ARP (IP and MAC address binding) ● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats	6
12	To design and analyze a computer network topology in Mininet, generate TCP and UDP traffic using iperf, and study their performance in terms of throughput, latency, and packet loss.	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

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on the 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)					
AIPCL502	Artificial Intelligence and Machine Learning Lab	-	25	25	-	-	50	1

Prerequisite: C programming language, Python programming	
Course Objectives: The lab course aims to	
1	Apply different AI agent architectures, search strategies and adversarial reasoning for solving real-world problem-solving tasks.
2	Familiarize learners with knowledge representation and reasoning techniques, including Prolog programming, Bayesian networks, and expert system design for intelligent decision-making.
3	Explore and utilize machine learning libraries and tools for data analysis and model building
4	Implement and evaluate supervised and unsupervised learning algorithms for real world datasets
5	Apply dimensionality reduction and Association rule mining technique for effective data interpretation and pattern discovery
Course Outcomes: On successful completion of lab course, learner will be able to	
1	Implement various AI search algorithms (uninformed, informed, local, adversarial) to solve state-space and game-playing problems.
2	Represent knowledge using logic and probabilistic models,including prolog programming,Bayesian belief networks, draw valid inferences, and develop simple expert systems for real-world applications.
3	Use python based machine learning libraries and framework to build models
4	Develop and analyze supervised learning models
5	Apply unsupervised learning techniques for clustering and dimensionality reduction

Suggested List of Experiments

(A minimum of 10 experiments should be performed covering all the COs)

Sr. No.	List of Experiments	CO Mapping
01	Provide the PEAS description and TASK Environment for a given AI problem.	1
02	Write simple programs using PROLOG as an AI programming Language.	2
03	(a) Implement any one of the Uninformed search techniques. (b) Implement any one of the Informed search techniquesE.g. A-Star algorithm for 8 puzzle problem. (c) Implement any one of the Local Search techniques.E.g. Hill Climbing, Simulated Annealing, Genetic algorithm	1
04	Implement adversarial search using min-max algorithm.	2
05	Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modeling Bayesian Networks)	2
06	Design a prototype of an expert system.	2
07	Study of Machine Learning Libraries and tools (Python library, tensorflow, keras,...)	3
08	Implementation of Principal Component Analysis for a given example data set.	5
09	Implementation of Naïve Bayes Classifier for a given example data set.	4
10	Implementation of Linear Regression for a given example data set.	4
11	Implementation of Support Vector Machines for a given example data set.	4
12	Implementation of K-Means/EM algorithm for a given example data set.	5
13	Implementation of Apriori algorithm for a given example data set.	5
14	Implement XGBoost for Classification and Regression	4

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 the 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
AIPEL 5011	**Optimization Learning Lab**	-	25	25	-	-	50	

Prerequisite: Basic programming knowledge, OOPs concept.	
Course Objectives: The lab course aims to	
1	To implement core optimization-oriented algorithms using C language.
2	To demonstrate Approximation, Randomized, Local Search, and String Algorithms through coding.
3	To analyze and compare algorithm performance and behavior.
4	To provide hands-on exposure to optimization ideas used in AI, search, and decision-making systems.
Course Outcomes: On successful completion of lab course, learner will be able to	
1	Implement and simulate optimization-oriented algorithms using C programming for problem solving.
2	Apply Approximation and Randomized strategies to design efficient solutions for NP-Hard problems.
3	Implement and analyze Local Search and Meta-heuristic algorithms for optimization tasks.
4	Execute and compare String Matching algorithms to improve search efficiency in large data/text.
5	Demonstrate Amortized Analysis concepts through implementation and performance observation.
6	Develop combinatorial problems and interpret results.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Implement Polynomial-time Reduction for SAT	01
02	Implement Backtracking-based Vertex Cover	01
03	Implement Greedy Approximation for Vertex Cover	02
04	Implement Bin Packing Algorithm (FF / BF / NF)	02
05	Implement Randomized QuickSort	03
06	Implement Randomized Min-Cut Algorithm	03
07	Implement Hill Climbing algorithm	04
08	Implement Z-Algorithm for Efficient Pattern Matching	04
09	Implement a Trie data structure for efficient string insertion, searching, and sorting operations.	05
10	Implement Aho–Corasick OR Z-Algorithm	05
11	Implement Traveling Salesman Problem using Genetic Algorithm	06
12	Implement Sequencing / Scheduling Optimization Problem	06

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 the 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)					
AIPEL 5012	**Statistics for Artificial Intelligence & Data Science Lab**	-	25	25	-	-	50	1

Prerequisite: Mathematical and Statistical Fundamentals, Programming Knowledge	
Course Objectives: The lab course aims to	
1	Apply theoretical statistical concepts using computational tools such as Python or R for data analysis.
2	Develop practical skills in data preprocessing, visualization, hypothesis testing, regression, and model evaluation.
3	Interpret statistical results and communicate findings effectively through visual and written analysis.
4	Integrate statistical methods into AI and Data Science workflows for solving real-world problems.
Course Outcomes: On successful completion of lab course, learner will be able to	
1	Perform data cleaning, preprocessing, and exploratory data analysis (EDA) using modern data-analysis tools.
2	Apply probability and sampling techniques to understand data distributions and variability.
3	Conduct hypothesis testing (t-test, Chi-square, ANOVA) and interpret significance levels for data-driven decision-making.
4	Build and evaluate regression models to analyze relationships and make predictions from data.
5	Implement non-parametric and advanced statistical inference techniques such as Kruskal–Wallis, Friedman's test, and bootstrap resampling.
6	Integrate all statistical methods in an end-to-end analysis workflow for real-world AI and Data Science applications.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Perform exploratory data analysis to summarize dataset characteristics and visualize data patterns.	01
02	Handle missing values, duplicates, and data transformation before analysis.	01
03	Visualize and understand random variables and probability distributions.	02
04	Perform hypothesis tests to validate statistical assumptions.	03
05	Perform variance analysis for multiple groups using ANOVA and non-parametric tests.	03
06	Analyze relationships between variables using correlation and linear regression.	04
07	Implement feature scaling techniques such as normalization and standardization on real-world datasets and compare their impact on model performance.	04
08	Apply logistic regression for classification and interpret model parameters.	04
09	Estimate uncertainty in model or sample statistics using bootstrap resampling.	05
10	Perform dimensionality reduction using Principal Component Analysis (PCA) and visualize transformed feature space.	05
11	Evaluate model generalization using cross-validation and statistical comparison.	06
12	Apply K-Fold Cross Validation to evaluate machine learning model generalization and compare validation scores.	06
13	Mini Project: Apply statistical methods from all modules to analyze a real dataset.	06

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 the 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
AIPEL 5013	IoT and Cloud Computing Lab	-	25	25	-	-	50	

Prerequisite: Fundamentals of Networking	
Course Objectives: The lab course aims to	
1	Introduce students to the fundamentals of IoT system design, device simulation, and architectural modeling.
2	Develop the ability to collect, process, and visualize IoT sensor data using open-source tools.
3	Understand and implement IoT communication protocols such as MQTT and CoAP for device-to-cloud communication.
4	Explore and apply cloud computing concepts for IoT data storage, deployment, and monitoring.
5	Familiarize students with virtualization and containerization techniques for scalable cloud infrastructure.
6	Implement basic IoT and cloud security mechanisms ensuring data integrity, confidentiality, and access control.
Course Outcomes: On successful completion of lab course, learner will be able to	
1	Simulate and configure smart IoT networks using Cisco Packet Tracer and design IoT system architectures based on layered models.
2	Collect, publish, and visualize real-time IoT sensor data using Node-RED and MQTT protocols.
3	Demonstrate IoT data flow across edge, fog, and cloud layers, and analyze performance using simulation tools like iFogSim.
4	Deploy IoT applications on cloud platforms such as ThingSpeak, AWS, or Azure and evaluate various service and deployment models.
5	Implement and compare virtualization and containerization environments using VirtualBox and Docker to understand cloud scalability.
6	Apply security techniques such as encryption and access control for safe data storage and transmission in IoT–Cloud integrated systems.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Simulation of Smart IoT Network using Cisco Packet Trace	1
02	Design of IoT System Architecture using Functional Layers	1
03	IoT Data Collection and Visualization using Node-RED	2
04	Simulation of Edge–Fog–Cloud Data Hierarchy using iFogSim	3
05	Implementation of MQTT Publish–Subscribe Communication	2
06	Demonstration of CoAP Protocol for IoT Communication	3
07	Deployment of IoT Application on Cloud Platform (ThingSpeak/Blynk)	4
08	Exploration of Cloud Deployment and Service Models using AWS/Azure	4
09	Comparison of Virtual Machines and Containers using Docker and VirtualBox	5
10	Implementation of Cloud Data Security using Encryption and Access Control	6
11	Interfacing of IoT Sensors and Actuators using Arduino/ESP32 and Data Transmission to Cloud.	5
12	Monitoring and Control of IoT Devices through Mobile App Integration using Blynk or MIT App Inventor.	5

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 the 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
AIPEL 5014	Cyber Security Lab	-	25	25	-	-	50	

Prerequisite: Computer Network, Programming logic	
Course Objectives: The lab course aims	
1	To understand and explore the fundamental tools, components, and configurations used in computer and network security, including wireless devices, firewalls, and security software.
2	To gain practical knowledge of network analysis and scanning tools such as Wireshark, Nmap, and reconnaissance utilities for identifying and analyzing network traffic and vulnerabilities.
3	To implement and demonstrate basic cryptographic techniques and algorithms, including classical ciphers for securing data communication.
4	To identify and analyze common system and web application vulnerabilities and understand mitigation techniques used to enhance cybersecurity.
Lab Outcomes: On successful completion of lab course, learner will be able to	
1	Analyze, configure, monitor, and analyze network traffic using tools like Wireshark and Nmap.
2	Demonstrate the ability to use reconnaissance and scanning utilities (WHOIS, nslookup, dig, traceroute) for information gathering and troubleshooting.
3	Configure, and operate security environments such as Kali Linux and firewalls for securing systems and networks.
4	Analyze and study basic encryption and decryption algorithms (e.g., Caesar Cipher) and explain their significance in securing data.
5	Recognize different types of cyber threats and vulnerabilities in wireless and web applications.
6	To apply appropriate security measures and best practices to protect networks, systems, and web applications from attacks and to identify and trace the path of an email using its header.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of different wireless network components and features of any one of the Mobile Security Apps.	**1**
02	To install and get familiar with Wireshark interface and features.	1
03	To capture and analyze different types of network packets in Wireshark.	1
04	Understand the nmap command d and scan a target using nmap .	2
05	Study the Installation of Kali Linux in Virtual box.	3
06	Explore Kali linux and bash scripting.	3
07	To Study about the features of firewalls in providing network security and to set Firewall Security in windows.	3
08	To Study the use of network reconnaissance tools like WHOIS, dig,traceroute, nslookup.	2
09	To implement the DES encryption and decryption using Python.	4
10	To implement the CaeserCipher algorithm for encryption and decryption of a plaintext message using Python.	4
11	To identify sender information and path from email headers.	6
12	To Study different types of vulnerabilities for hacking a website/ Web Applications.	5,6

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

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on the 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)

- Lab Performance: 10 Marks
- In-Semester Practical Exam during lab session: 10 Marks
- 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
ETMDML501	**Digital Communication & Sensor Technology Lab**	-	25	-	-	-	25	

Prerequisite:	
Course Objectives: The lab 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: On successful completion of lab course, learner 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	1
02	To study and perform Pulse Code Modulation (PCM) and Demodulation of an analog signal.	1
03	To calculate the amount of information and entropy for a given discrete message source.	2
04	To design and implement Huffman coding for a given discrete source and calculate code efficiency and redundancy.	2
05	Linear block code generation and error detection	3
06	Cyclic code generation and error detection	3
07	Convolutional code generation	3
08	Line Codes generation and performance comparison	4
09	Generation (and detection) of Binary ASK, Binary PSK, and Binary FSK.	4
10	Generation (and detection) of QPSK	4
11	Study of Characteristics of a Potentiometer as a Displacement Sensor	5
12	Study of LVDT (Linear Variable Differential Transformer) Characteristics	5
13	Study of Capacitive Transducer for Displacement or Pressure Measurement	5
14	Study and Characterization of a Thermistor (Temperature Sensor)	6
15	Study of Photo-resistive Sensor (LDR) characteristics (Light intensity vs resistance)	6
16	Demonstration of MEMS-based sensors (e.g., accelerometer, pressure sensor using Arduino or NI-ELVIS)	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
ARMDML 501	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.
5	Implement PLC programs for automation applications.
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)

- Lab Performance: 10 Marks
- 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
ITMDM L501	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	1
02	Interfacing MEMS accelerometer (MPU6050) with Arduino	2
03	Interfacing servo and stepper motors using PWM	4
04	Interfacing DC motor with H-bridge driver circuit	4
05	Study of piezoelectric transducer	2
06	Signal conditioning for sensor data (amplifier + filter)	3
07	IoT data acquisition using ESP32/ESP8266 and cloud platform	3
08	Calibration and performance evaluation	2,3,4
09	Mini project using sensors and actuators	1,2,3,4
10	Measurement of temperature using DHT11, thermistor, thermocouple, LM35	2
11	Measurement of pressure using Piezoelectric sensor, Bourdon tube, Strain-gauge pressure sensor, BMP180, MPX5010	2
12	Demonstration of IR sensor for proximity sensing	3

13	Automatic lighting system using LDR	3
14	Motion detection using MEMS Accelerometer (ADXL335, MPU6050), Gyroscope	3,4

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
MEMD ML501	Renewable Energy Sources Lab	-	25	-	-	-	25	

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 Component & layout of thermal power plant.	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 Component & layout of nuclear power plant.	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
4.

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
EEMDM L501	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.	5
02	Simulation on Modelling of PV system using MATLAB.	6
03	Simulation on Modelling of DFIG based wind power system.	6
04	Simulation of Grid connected PV MPPT single stage. CO1	6
05	To measure and analyze the power quality parameters with and without compensation. (voltage, THD, pf and current)	5
06	Simulation/Emulation of DC Microgrid with steady state/transient performance analysis	5
07	Simulation/ Emulation of AC Microgrid with steady state/transient performance analysis.	5
08	Study of solar PV characteristics	6
09	Study of constructional features and working principle of different special motors (Stepper, SRM, BLDC, PMSM, LIM).	1,2,3,4
10	Speed control of a Stepper Motor using Arduino or Microcontroller Interface.	1
11	Determination of Step Angle and Resolution of Stepper Motor.	1
12	Characteristics of Switched Reluctance Motor (SRM).	2
13	Speed control of SRM using a power converter.	2
14	Study of Permanent Magnet Synchronous Motor (PMSM).	4
15	Experimental setup of PMSM drive using inverter and controller.	4
16	Study of BLDC motor and its characteristics.	3
17	Integration of special motor with sensor and control module for application (e.g., robotic arm / conveyor).	3

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

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

Continuous Internal Evaluation (25 Marks)

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

Department of Computer Science and Engineering
(Artificial Intelligence & Machine Learning)

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
AIPCC601	Deep Learning	20	20	60	1	2	100	

Prerequisite: Mathematics, Machine learning	
Course Objectives: The course aims to	
1	Understand the fundamentals concepts of Neural Network.
2	Apply suitable activation,loss function and optimization techniques for effective training of deep neural network
3	Develop and evaluate unsupervised and supervised deep learning architectures such as Autoencoders, CNN,and RNN
4	Analyze and implement advanced deep learning models for sequence, image and text-based data
5	Explore Transformer-based models used in modern AI systems.
Course Outcomes: Learners will be able to	
1	Illustrate the structure, functioning of deep learning models
2	Implement and train deep neural networks using appropriate activation function,loss function and optimization algorithm
3	Design and evaluate Autoencoders for unsupervised learning and dimensionality reduction
4	Construct Convolutional Neural Network for image-based task
5	Apply Recurrent Neural Network,LSTM,GRU for sequence,time series data modeling
6	Apply Transformer models and attention mechanisms for AI applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundation of Neural Network and Deep learning**	5	CO1
	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture		
	History of Deep Learning, Deep Learning Success Stories, Multilayer Perceptrons (MLPs), Representation Power of MLPs,		

	Sigmoid Neurons,Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks		
	Deep Networks: Three Classes of Deep Learning Basic Terminologies of Deep Learning		
	Self Learning Topic: Universal Approximation Theorem		
02	**Training, Optimization and Regularization Techniques**	9	**CO2**
	Training Feedforward DNN Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function		
	Optimization Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD,Nesterov Accelerated GD, AdaGrad, Adam, RMSProp		
	Regularization Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output		
	Self Learning Topic : Learning rate scheduling, gradient clipping		
03	**Autoencoders: Unsupervised Learning**	6	**CO3**
	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders		
	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders, Application of Autoencoders: Image Compression,anomaly detection		
	Self Learning Topic: Comparison of Autoencoder and PCA		
04	**Convolutional Neural Networks (CNN): Supervised Learning**	8	**CO4**
	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, Multichannel convolution operation.		
	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture, VGGNet: Architecture,GoogleNet: Architecture, ResNet : Architecture		
	Self Learning Topic: Modern CNN architecture: EfficientNet**,** YOLO for Object Detection		
05	**Recurrent Neural Networks (RNN)**	8	**CO5**
	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of " vanilla RNN" Vanishing and		

	Exploding Gradients, Truncated BTT		
	Long Short Term Memory(LSTM): Selective Read, Selective write, Selective Forget, Gated Recurrent Unit (GRU)		
	Self Learning Topic: Applications of RNN in text and speech processing		
06	**Transformers and Attention Mechanism**	**6**	**CO6**
	Encoder Decoder Models, Attention Mechanism, Attention over images, Applications of Transformers, BERT and GPT - Basis Overview		
	Self Learning Topic: Applications of Generative AI using Transformers		

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2. Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIT Press.
6. Zhou, Z.H., 2012. Ensemble methods: foundations and algorithms. CRC press.

References:

1. Deep Learning from Scratch: Building with Python from First Principles- Seth Weidman by O`Reilley
2. François Chollet. ―Deep learning with Python ―(Vol. 361). 2018 New York: Manning.
3. Douwe Osinga. ―Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
4. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India
6. https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLEAYkSg4uSQ1r-2XrJ_GBzzS_6I-f8yfRU

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
AIPCC602	**Software Engineering and Project Management**	20	20	60	1	2	100	

Prerequisite: Programming fundamentals, OOPs Concept, DBMS	
Course Objectives: The course aims to	
1	Understand fundamental software engineering principles, software development life cycle models, and Agile development practices for building quality software systems.
2	Analyze and document software requirements, perform software estimation, and design software architectures using appropriate modeling techniques and design principles.
3	Apply software quality assurance, testing, configuration management, and maintenance practices to ensure reliable and maintainable software systems.
4	Develop project management and teamwork skills for planning, scheduling, monitoring, and executing software projects using modern project management practices and tools.
Course Outcomes: Learners will be able to	
1	Illustrate software engineering fundamentals, SDLC models, Agile methodologies, and software process improvement concepts.
2	Identify, analyze, and document software requirements and apply software estimation techniques for project planning.
3	Design software systems using appropriate architectural styles, UML diagrams, design principles, and design patterns.
4	Apply software quality assurance, risk management, configuration management, and version control practices in software development.
5	Perform software testing and maintenance activities using appropriate testing techniques and maintenance practices.
6	Plan, schedule, and manage software projects using project management techniques, Agile practices, and project management tools.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Software Engineering Fundamentals and Agile Development**	07	CO1
	Nature and Evolution of Software, Software Characteristics, Software Development Life Cycle (SDLC), Process Models: (Waterfall, Incremental, Spiral, Evolutionary Process Model), Concurrent Models, Agile Process, Agility principles, Kanban, Scrum, Extreme Programming, Introduction to DevOps, Software Process Improvement (CMMI).		
	Self Learning Topic: Explore Agile project management using Scrum boards and sprint planning tools.		
02	**Requirements Engineering and Software Estimation**	07	CO2
	Software Requirements:Functional & Non-functional Requirements, Requirement Engineering Process, Feasibility studies, software prototyping, S/W documentation, Software requirement specification (SRS) 3Ps (people, product and process) Process and Project metrics, Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model.		
	Self Learning Topic: Create Software Requirement Specification (SRS) document for a simple application.		
03	**Software Design and Architecture**	07	CO3
	Software Design Concepts and Principles, Modularity, Cohesion, and Coupling, Architectural Design Concepts, Architectural Styles: (Layered Architecture, MVC Architecture, Microservices), UML Diagrams: (Use Case Diagram, Class Diagram, Sequence Diagram) User Interface Design Principles, Introduction to Design Patterns: (Singleton, Factory, Observer), Software Refactoring Concepts		
	Self Learning Topic: Create UML diagrams for a simple software system using StarUML or Lucidchart.		
04	**Software Quality and Configuration Management**	06	CO4
	Software Quality Concepts, Software Quality Assurance (SQA), Software Reviews and Walkthroughs, Risk Management: (Risk Identification, Risk Analysis, Risk Mitigation), Software Configuration Management (SCM), Version Control using Git, Basics of Continuous Integration (CI), Introduction to Software Security and OWASP.		
	Self Learning Topic: Study Git and GitHub workflows for version control and collaboration.		
05	**Software Testing and Maintenance**	07	CO5
	Fundamentals of Software Testing, Verification and Validation, Testing Levels: (Unit Testing, Integration Testing, System Testing, Acceptance Testing), Regression Testing, Black Box and White Box Testing, Introduction to Test Automation, Software Maintenance:		

	(Corrective, Adaptive, Perfective, Preventive), Reverse Engineering and Refactoring		
	Self Learning Topic: Explore Selenium or JUnit for automated software testing.		
06	**Software Project Management and Agile Practices**	08	**CO6**
	Introduction to Software Project Management, Project Planning and Scheduling, Feasibility Study and Project Scope, Work Breakdown Structure (WBS), Gantt Charts, Network Diagrams: (CPM, PERT), Agile Project Management Basic, Team Management and Communication, Introduction to Project Management Tools: (Jira, Trello)		
	Self Learning Topic: Create a project schedule and sprint plan using Jira or Trello.		

Text Books:

1. Roger S. Pressman – *Software Engineering: A Practitioner's Approach*, McGraw Hill.
2. Rajib Mall – *Fundamentals of Software Engineering*, PHI.
3. John M. Nicholas – *Project Management for Business and Technology*, Pearson.
4. Srinivasan Desikan & Gopalaswamy Ramesh - *Software Testing Principles and Practices.*

References:

1. Nicole Forsgren, Jez Humble, Gene Kim – *Accelerate: The Science of Lean Software and DevOps.*
2. Jez Humble & David Farley – *Continuous Delivery.*
3. Ken Schwaber – *Agile Project Management with Scrum.*
4. Titus Winters et al. – *Software Engineering at Google.*
5. Pankaj Jalote – *An Integrated Approach to Software Engineering*, Springer.

Online References:

1. https://nptel.ac.in/courses/106105182?
2. https://nptel.ac.in/courses/106101061?
3. https://www.youtube.com/playlist?list=PLbRMhDVUMngf8oZR3DpKMvYhZKga90JVt
4. https://nptel.ac.in/courses/111105902?

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)

Assignment: 5 Marks
Quiz/Open book test/Presentation: 10 Marks
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
AIPEC 6011	Cryptography and System Security	20	20	60	1	2	100	

Prerequisite:Computer Network	
Course Objectives: The course aims to	
1	Introduce the fundamental concepts of cryptography, including classical and modern encryption techniques.
2	Familiarize students with symmetric and asymmetric cryptographic algorithms and their applications
3	Explain the principles of message authentication, hashing, and digital signatures.
4	Describe various authentication protocols and system security mechanisms.
5	Discuss operating system, database, and web security mechanisms to safeguard information systems.
6	Develop an understanding of current security threats and defensive techniques used in modern systems.
Course Outcomes: Learners will be able to	
1	Understand classical cryptographic techniques and mathematical foundations of cryptography.
2	Apply symmetric and asymmetric key cryptographic algorithms for data protection.
3	Analyze message authentication codes and cryptographic hash functions.
4	Examine digital signature schemes and authentication protocols.
5	Explain security measures in operating systems and databases.
6	Illustrate various web security threats and defense mechanisms.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction- Number Theory and Basic Cryptography** 1.1 Introduction of Cryptography,Security Goals,Services, Mechanisms and Attacks-the OSI security architecture-Network security model-,.Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem. 1.2 Classical Encryption techniques (Symmetric cipher model,mono-alphabetic and poly-alphabetic substitution techniques: Vignere cipher, playfair cipher, Hill cipher, One-Time Pad,transposition techniques: keyed:Rail Fence Cipher, and keyless	8	CO1

	transposition ciphers: Columnar Transposition, Double Transposition, steganography,Product Cipher		
	Self Learning Topic: Illustrate various web security threats and defense mechanisms.		
02	**Block Ciphers & Public Key Cryptography** 2.1 Block cipher principles, block cipher modes of operation,Symmetric (Private Key) Algorithms: DES, Double DES, Triple DES, Advanced Encryption Standard (AES),Blowfish,Twofish, Stream Ciphers: RC4,RC5 algorithm,ChaCha20. 2.2 Public key cryptography: Principles of public key cryptosystems-The RSA Cryptosystem, The knapsack cryptosystem, 2.3 Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, ECDH (Elliptic Curve Diffie–Hellman),Public key Distribution: Digital Certificate: X.509, PKI . **Self Learning Topic:** Hybrid Encryption, Comparison of Symmetric and Asymmetric Systems, Real-world use of PKI and SSL Certificates	8	**CO2**
03	**Cryptographic Hashes, Message Digests and Digital Certificates** Authentication requirement – Authentication function , Types of Authentication, MAC – Hash function – Security of hash function and MAC,MD5 , SHA ,HMAC,CMAC, Digital Certificate: X.509, PKI **Self Learning Topic:** Blockchain and Hashing, Real-world Certificate Validation, Difference between HMAC and CMAC.	7	**CO3**
04	**Digital signature schemes and authentication Protocols** Digital signature and authentication protocols : Needham Schroeder Authentication protocol,Digital Signature Schemes – RSA,, DSA Cryptosystem,ECDSA (Elliptic Curve DSA),EdDSA (Edwards-Curve DSA), EI Gamal and Schnorr, DSS **Self Learning Topic:** Real-life Applications of Digital Signatures, Comparison between RSA and DSA, Role of Digital Signatures in E-Governance	**6**	**CO4**
05	**System Security** Operating System Security: Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, FileSystem Security Database Security: Database Security Requirements, Reliability and Integrity,Sensitive Data, Inference Attacks, Multilevel Database Security **Self Learning Topic:** Access Control Models (DAC, MAC, RBAC), Buffer Overflow Prevention, Database Encryption Techniques.	7	**CO5**
	Web security		
06		6	**CO6**

	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Web Browser Attacks, WebBugs, Clickjacking, CrossSite Request Forgery, Session Hijacking and Management, Phishing Technique, DNS Attack, Secure Electronic Transaction, Email Attacks, Firewalls, Penetration Testing.		
	Self Learning Topic: Web Application Firewalls, OWASP Top 10, Secure Coding Practices, Role of TLS Certificates.		

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley
5. Mark Stamp‘s Information Security Principles and Practice, Wiley

References:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson. 5.

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
AIPEC 6012	Natural Language Processing	20	20	60	1	2	100	

Prerequisite: Programming logic, Machine learning	
Course Objectives: The course aims to	
1	Understand the fundamentals and linguistic foundations of Natural Language Processing and its core components.
2	Apply word-level analysis and language modeling techniques using text preprocessing and probabilistic models.
3	Perform syntactic analysis through POS tagging, parsing, and statistical sequence labeling methods.
4	Analyze semantic structures and implement word sense disambiguation techniques for meaning representation.
5	Examine pragmatics and discourse processing to interpret context, reference, and coherence in language.
6	Explore large language models, their architectures, fine-tuning methods, and applications in modern NLP tasks.
Course Outcomes: Learners will be able to	
1	Understand the fundamentals, levels, challenges, and real-world applications of Natural Language Processing.
2	Apply text preprocessing and language modeling techniques to prepare and analyze textual data effectively
3	Analyze and implement POS tagging and parsing methods to extract syntactic structures from text.
4	Represent and disambiguate word and sentence meaning using semantic resources and Word Sense Disambiguation techniques.
5	Understand and apply discourse and pragmatic analysis, including anaphora resolution and coherence in text.
6	Understand, fine-tune, and apply Large Language Models for modern NLP tasks responsibly.

	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** Introduction to NLP, Origin and History of NLP, Need for NLP in modern systems, Generic NLP Pipeline, Levels of NLP: Phonology,		CO1

	Morphology, Syntax, Semantics, Pragmatics, Knowledge in Language Processing, Ambiguity in Natural Language, Challenges in NLP, Applications of NLP in industry and research. **Self-Learning Topics:**NLP for Indian Languages, Unicode and Tokenizers, variety of tools for regional language preprocessing and data formats.	4	
02	**Text Processing and Word-Level Analysis** 2.1 Introduction to Lexical Processing:Words and lexical units, Basic word representation. 2.2 Text Preprocessing: Sentence segmentation, Tokenization, Normalization, Stop-word removal, Overview of stemming and lemmatization. 2.3 Empirical Laws on Raw Text: Zipf's Law, Heaps' Law, Frequency distributions. 2.4 Morphological Analysis: Morphemes, Inflectional and Derivational morphology. 2.5 Regular Relations and Finite-State Morphology: Regular expressions, Finite-state automata, Finite-state transducers, Morphological parsing. 2.6 Stemming and Lemmatization: Porter algorithm, Snowball algorithm, Dictionary-based lemmatization, Rule-based lemmatization. 2.7 Statistical Language Models: N-gram Models-Unigram, Bigram, Trigram Smoothing Techniques: Laplace smoothing,Good–Turing smoothing Evaluation Metrics: Perplexity 2.8 Word Representation Models: Bag of Words, TF-IDF, Feature vectors. **Self Learning Topic:** Case study: Development of a Text Analytics Pipeline for News Articles	8	**CO2**
03	**Syntax Analysis** 3.1 Part-of-Speech Tagging: Stochastic POS Tagging, Hidden Markov Models (HMM), Viterbi Algorithm, Challenges in POS Tagging. 3.2 Discriminative Models for Sequence Labeling: Maximum Entropy Markov Models (MEMM), Conditional Random Fields (CRF), BiLSTM-CRF Models. 3.3 Grammar Formalisms: Context-Free Grammars (CFG), Constituency Structure, Probabilistic CFGs (PCFG), Introduction to Dependency Grammar. 3.4 Parsing Techniques: Constituency Parsing:Parse Trees, Top-Down Parsing(Predictive Parser & Earley Parser). Bottom-Up Parsing: Shift-Reduce Parsing, CKY Algorithm Dependency Parsing: Dependency Trees, Transition-Based Overview	8	**CO3**

	Self Learning Topic: Case Study: Building a Complete Syntactic Analysis System for English Sentences		
04	**Semantic Analysis** 4.1 Meaning Representation Lexical Semantics, Word Sense Representation, Study of WordNet, BabelNet, Lexical Relations: Synonymy, Hyponymy, Hypernymy, Antonymy, Homonymy, Polysemy, etc. Semantic Ambiguity 4.2 Word Sense Disambiguation (WSD) Knowledge-Based (Lesk Algorithm), Supervised (Naïve Bayes, Decision List), Semi-Supervised (Yarowsky Algorithm), Unsupervised (HyperLex)	7	**CO4**
	Self Learning Topic: Word Embeddings and Semantic Similarity: Word2Vec, GloVe, FastText, and their Applications in Word Sense Disambiguation.		
05	**Pragmatics & Discourse Processing** 5.1 Pragmatics Introduction to Pragmatics,Speech Acts Theory, Deixis & Reference, Reference Phenomena, Reference Resolution, Syntactic & Semantic Constraints on Coherence 5.2 Anaphora & Discourse Anaphora Resolution : Hobbs' Algorithm, Centering Theory. Predicate-Argument Structure, Cohesion and Coherence in Discourse, Meaning Representation Systems, Discourse Structure and Processing,	6	**CO5**
	Self Learning Topic: Coreference Resolution and Conversational AI using Transformer-Based Language Models		
06	**Large Language Models and Applications in NLP** 6.1 Large Language Models (LLMs) Evolution of NLP: Statistical NLP , Neural NLP , Transformers, Large Language Models Foundations of LLMs: Introduction to LLMs , Transformer Architecture Recap: Encoder-Decoder Architecture , Self-Attention, Positional Encoding Tokenization and Context Processing: Subword Tokenization, Context Windows, Context Length Limitations Training Paradigms: Pre-training, Fine-tuning, Transfer Learning Adapting LLMs: PromptEngineering:Zero-shot,Few-shot,Chain-of-Thought Parameter-Efficient Fine-Tuning :LoRA, PEFT Popular LLM Families: GPT , BERT, T5, LlaMA, Falcon, Mistral Evaluation of LLMs: Perplexity, BLEU, Factuality, Hallucination Analysis	9	**CO6**

	Ethical and Responsible AI: Bias, Fairness, Misinformation, Hallucinations, Privacy, Safety 6.2 Modern NLP Applications Text Classification (Sentiment Analysis, Spam Detection), Named Entity Recognition, Machine Translation Text Summarization (Extractive, Abstractive)		
	Self Learning Topic: Retrieval-Augmented Generation (RAG) and AI Assistants		

Text Books:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

References:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Daniel M Bikel and ImedZitouni - Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3. Nitin Indurkhya and Fred J. Damerau, -Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
4. https://nptel.ac.in/courses/106105158

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~~	~~Course Name~~	**Examination Scheme**	**Lecture**

Code		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
AIPEC 6013	**Nature Inspired Computing**	20	20	60	1	2	100	

Prerequisite:Analysis of algorithm.	
Course Objectives: The course aims to	
1	To introduce the fundamental concepts and biological inspirations behind nature-inspired algorithms
2	To develop the ability to design and implement nature-inspired techniques for optimization and learning tasks
3	To foster analytical thinking for evaluating the performance and applicability of NIC methods
4	To encourage interdisciplinary innovation by integrating NIC with sustainable, intelligent, and ethical systems
Course Outcomes: Learners will be able to	
1	Explain the fundamental principles and philosophy behind nature-inspired computing and its relationship with natural systems.
2	Analyze the key concepts of self-organization, emergence, adaptation, and complexity in computational models.
3	Apply evolutionary algorithms such as Genetic Algorithms, Evolutionary Programming, and Genetic Programming for solving optimization problems.
4	Examine the working principles and applications of Swarm Intelligence techniques including Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO).
5	Describe and design computational models inspired by biological immune systems for pattern recognition and anomaly detection.
6	Evaluate and compare various nature-inspired computing paradigms for real-world engineering and optimization problems.

	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** 1.1 Philosophy, History, Applications, Need and Scope, Natural vs Artificial Systems, From Nature to Natural Computing 1.2 Search for Optimality, Optimization Algorithms: Gradient Based Algorithms, Hill Climbing with random restart (traditional to heuristic	4	**CO1**

	search) 1.3 Bottom-up vs Top-down Design		
02	**Principles of Natural Computation (The Strategy)** 2.1 Exploration and exploitation; Individuals, Entities and Agents; Parallelism and Adaptation; Feedback and Self-Organization Systems; Evolutionary Operators (Introduction to selection pressure and variance) 2.2 Complexity, Emergence and Chaos and Fractals **Self Learning Topic: Self-organization, Chaos, Fractals, Agent-based modeling**	4	**CO2**
03	**Evolutionary Computing and Optimization** 3.1 Darwin's Ideas (Biological Foundation), Evolutionary principles,Evolutionary Operators; 3.2 A Standard Evolutionary Algorithm 3.3 Genetic Algorithms: Reproduction, Crossover, Mutation; Differential Evolution (Vector-based optimization) ; Evolutionary Programming (Finite state machine optimization) ; Genetic Programming (Evolving computer code/tree structures) **Self Learning Topic: GA Applications, Comparison of algorithms, Open-source tools**	8	**CO3**
04	**Swarm Intelligence and Collective Behavior** 4.1 Swarm Intelligence and Collective Behavior; Biological Foundations: Foraging and Social Knowledge Adaptation ; 4.2 Simple Ant Colony Optimization (SACO) & Ant Colony Optimization (ACO)**;** Bee Algorithms; Particle Swarm Optimization (Democratic flocking) ; Grey Wolf Optimizer (GWO) (Hierarchical hunting); 4.3 Specialized Metaheuristics: Nature Inspired Metaheuristics Overview; The Firefly Algorithm, Cuckoo Search, The Bat Algorithm, The Flower Algorithm;	9	**CO4**
05	**Immunocomputing and Artificial Immune Systems (AI)** 5.1 Immune System Concepts (Innate vs. adaptive immunity, antigens, antibodies); Pattern Recognition in Immune Systems. 5.2 Forest's Algorithm (Negative Selection Algorithm for anomaly detection); Bone Marrow Models (Gene library generation mechanisms). 5. 3 Immune Network Theory & Danger Theory (Dynamic regulation and threat localization); Artificial Immune Networks (AINet) & Immune Algorithms (Clonal Selection, Clonalg)	9	**CO5**
06	System Performance, Control, and Advanced Applications 6.1 Parameter Tuning (Static setup before runtime); Parameter Control (Dynamic adaptation during runtime); 6.2 Hybrid and Adaptive Evolutionary Systems (Combining EAs,	8	**CO6**

	Swarms, or AIS); Simulated Annealing (Trajectory-based cooling metaheuristic); 6.3 Comprehensive Applications (Case studies across industry/ finance/ robotics/ cyber security)		
	Self Learning Topic: AIS in Security, Negative Selection, Immune Learning		

Text Books:

1. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
2. Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press, 2008

References:

1. Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
2. Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi,2005
3. Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi, 2020

E-Resources

1. NPTEL Courses on Evolutionary Computing and Computational Intelligence. https://nptel.ac.in/courses/112103301
2. Open-access book: *Evolutionary Algorithms* by Eisuke Kita and Hiroyuki Iba.
3. Research papers and survey articles on recent nature-inspired optimization algorithms.

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
AIPEC 6014	**Augmented Reality and Virtual Reality**	20	20	60	1	2	100	

Prerequisite: Mathematics, Machine learning	
Course Objectives: The course aims to	
1	Understand the concepts, taxonomy, and hardware of immersive technologies like VR, AR, and XR
2	Apply graphics, rendering, and interaction techniques to design realistic and user-centered immersive environments.
3	Integrate hardware, sensors, and software tools for developing real-time immersive systems and explore emerging trends and ethics.
Course Outcomes: Learners will be able to	
1	Describe and differentiate the concepts, taxonomy, and hardware components of immersive technologies including VR, AR, and XR.
2	Apply computer graphics and rendering techniques to develop visually realistic and low-latency VR/AR environments.
3	Design and implement user-centered interactive environments using gesture recognition, tracking, and spatial navigation methods.
4	Develop Augmented Reality (AR) applications using computer vision-based tracking (marker-based, markerless, SLAM) and evaluate their usability.
5	Integrate hardware devices, sensors, and software frameworks (Unity, Unreal, Blender) for real-time immersive system development and optimization.
6	Analyze and evaluate emerging applications, AI-based enhancements, and ethical implications of immersive technologies in various domains.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundations of Virtual and Augmented Reality** 1.1 Introduction to VR/AR/MR/XR: Concepts, Components, and Taxonomy; Immersion, Presence and Interactivity; Degrees of Freedom (3DoF and 6DoF); Human Factors in VR/AR: Ergonomics, Motion Sickness and Cybersickness; Benefits and Applications of Immersive Technologies; 1.2 Historical Development and Scientific Milestones in Virtual and Augmented Reality	**05**	**CO1**

	1.3 VR/AR Hardware Ecosystem: Head-Mounted Displays (HMDs), Trackers, Sensors, Motion Capture Systems, Haptic Devices, and Data Gloves 1.4 VR/AR Development Platforms and Standards: Unity, Unreal Engine, OpenXR and Related Development Tools		
	Self Learning Topic: Explore the evolution of immersive technologies through landmark VR/AR systems and their impact on current platforms.		
02	**Visual Computation and Real-Time Rendering**	**05**	**CO2**
	2.1 Fundamentals of Computer Graphics for VR/AR: Graphics Pipeline, Coordinate Systems, 2D to 3D Conversion, Perspective Projection, Human Vision and Stereo Perception 2.2 Shading, Illumination and Reflection Models: Phong and Gouraud Shading 2.3 Scene Management and Optimization: Scene Graphs, Level of Detail (LOD), Frustum Culling and Depth Buffering (Z-Buffer) 2.4 Real-Time Rendering Techniques: Frame Reprojection, Low-Latency Rendering and Performance Optimization		
	Self Learning Topic: Study ray tracing and path tracing techniques for achieving photorealistic rendering in VR/AR.		
03	**Interaction and User-Centered Design**	**08**	**CO3**
	3.1 Interaction Techniques: Gesture Recognition (ML/HMM-Based), Body Tracking, Eye Tracking, Object Manipulation and 3D Menus 3.2 User Interface and Navigation in 3D Space, User Experience (UX), Accessibility and Inclusive Design Principles 3.3 Iterative Design Methodology: Define–Make–Learn Cycle, Environmental and Spatial Design using Unity and Unreal Engine 3.4 Input and Output Technologies: Haptics, Controllers, Audio Feedback and Visual Feedback		
	Self Learning Topic: Research usability evaluation methods for immersive interfaces and how user feedback shapes VR/AR design.		
04	**Augmented and Mixed Reality**	**09**	**CO4**
	4.1 AR and MR Concepts, Taxonomy, Features and System Architecture 4.2 Tracking and Registration Techniques: Marker-Based Tracking (ArUco), Markerless and Feature-Based Tracking (ORB, SIFT), and SLAM 4.3 Visualization Techniques, Spatial Mapping and Environmental Understanding in Mobile AR 4.4 AR Frameworks and SDKs: ARCore, ARKit, Vuforia, Mixed Reality Toolkit (MRTK), Enhancing Interactivity and Evaluation Methods for AR Systems		
	Self Learning Topic: Explore advances in SLAM algorithms for markerless AR and their use in mobile applications.		
05	**Software Development and System Integration**	**08**	**CO5**
	5.1 VR/AR Software Development Pipeline and OpenXR-Based Cross-Platform Development 5.2 Modeling, Annotation and Asset Integration using Blender and Unity		

	5.3 Sensor Fusion and Device Integration: IMU, GPS, Cameras and Environmental Sensors 5.4 Multi-User Networking in Shared Virtual Environments, Real-Time Performance Tuning, Optimization and Debugging		
	Self Learning Topic: Study the role of cloud and edge computing in supporting multi-user and distributed immersive environments.		
06	**Applications and Future Trends**	**07**	**CO6**
	6.1 Applications of VR/AR in Gaming, Digital Media, Healthcare, Education, Engineering, Manufacturing and Training 6.2 Artificial Intelligence in VR/AR: Gesture Recognition, Object Detection (CNN), Scene Understanding, Intelligent Virtual Agents and AI-Driven Personalized Learning 6.3 Emerging Trends in Immersive Technologies: Metaverse, Digital Twins, Cloud Rendering, Edge AI for XR and 6DoF Tracking 6.4 Ethics, Privacy, Security and Societal Implications of Immersive Technologies		
	Self Learning Topic: Investigate the concept of the Metaverse and its convergence with AI and immersive technologies.		

Text Books:

1. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2017.
2. Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, ACM Books, 2016.
3. José María Ariso (Ed.), Augmented Reality: Reflections on Its Contribution to Knowledge Formation, De Gruyter Open, 2017.
4. Learning Virtual Reality, O'Reilly Media, 2015.

References

1. M. Claudia tom Dieck, Timothy H. Jung, and Sandra M.C. Loureiro (Eds.), Augmented Reality and Virtual Reality: Empowering Human, Place and Business, Springer, 2021.
2. Steve Mann, Tom Furness, et al., All Reality: Virtual, Augmented, Mixed (X), Mediated (X,Y), and Multimediated Reality, arXiv, 2018.
3. Vitalii Ivanov, Ivan Pavlenko, Artem Evtuhov, and Justyna Trojanowska, Augmented Reality for Engineering Graphics, Springer, 2020.
4. Augmented Reality for Engineering Graphics, Springer, 2020.
5. https://nptel.ac.in/courses/106106138?utm_source=chatgpt.com

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
AIPEC 6021	Distributed Computing	20	20	60	1	2	100	

Prerequisite: Computer Network,Operating System,Programming knowledge	
Course Objectives: The course aims	
1	To provide students with contemporary knowledge in distributed systems.
2	To equip students with skills to analyze and design distributed applications.
3	To provide master skills to measure the performance of distributed synchronization algorithms.
4	To equip students with skills to availability of resources.
5	To provide master skills to distributed file systems.
Course Outcomes: Learners will be able to	
1	Demonstrate knowledge of the basic elements and concepts related to distributed system technologies.
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3	Analyze the various techniques used for clock synchronization and mutual exclusion.
4	Demonstrate the concepts of Resource and Process management and synchronization algorithms.
5	Demonstrate the concepts of Consistency and Replication Management.
6	Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Distributed Systems** 1.1 Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept, AI-driven Resource Allocation in Distributed Systems 1.2 Middleware: Models of Middleware, Services offered by middleware, Client Server model, AI and ML Middleware Services.	08	**CO1**

	Self Learning Topic: Build a simple client-server chat application using Python sockets or Java RMI, Implement a distributed file-sharing system prototype.		
02	**Communication** 2.1 Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI), Data Serialization Frameworks 2.2 Message Oriented Communication, Stream Oriented Communication, Group Communication, Event-driven and Asynchronous Messaging Systems. Self Learning Topic: Develop a Java RMI calculator service. Simulate group communication with leader election using Python sockets.	06	**CO2**
03	**Synchronization** 3.1 Clock Synchronization, Physical Clock, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of Mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure. 3.2 Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm. 3.3 Token Based Algorithms: Suzuki-Kasami's Broadcast Algorithms, Singhal's Heuristic Algorithm, Raymond's Tree.based Algorithm, Comparative Performance Analysis. **Self Learning Topic:** Implement logical clocks, election, and mutual exclusion in Python or Java, Design a simple election algorithm for a distributed file-sharing app.	09	**CO3**
04	**Resource and Process Management** 4.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Autonomous and Self-optimizing Resource Management. 4.2 Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration, Lightweight Virtualization, Security and Isolation in Virtualized Environments **Self Learning Topic:** Build a load balancing simulator for 3–4 node,, Simulate a simple scheduler that assigns tasks dynamically, Create a Docker-based distributed setup to understand virtualization.	06	**CO4**
05	**Consistency, Replication and Fault Tolerance** 5.1 Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management. 5.2 Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery	07	**CO5**

	Self Learning Topic: Case study on Amazon Dynamo (eventual consistency),Case study on Hadoop's HDFS block replication		
06	**Distributed File Systems and Name Services** 6.1 Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Distributed File Systems (DSF), Network File System (NFS), Andrew File System (AFS), HDFS, Data Deduplication and Compression in DFS. 6.2 Designing Distributed Systems: Google Case Study. Case Study: Network File System (NFS) **Self Learning Topic:** Build a prototype showing data replication and recovery.Connect a local Hadoop setup to cloud storage like AWS S3.	06	**CO6**

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, , "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

References:

1. A. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
2. M. L. Liu, "Distributed Computing Principles and Applications", Pearson Addison Wesley, 2004.
3. Learn to Master Distributed Computing by ScriptDemics, StarEdu Solutions

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
AIPEC 6022	Data Analytics and Visualization	20	20	60	1	2	100	

Prerequisite: Mathematics,Machine Learning, Python Programming	
Course Objectives: The course aims to	
1	To develop a comprehensive understanding of data analytics concepts, types, and statistical foundations essential for analyzing business data.
2	To enable students to perform exploratory data analysis, visualization, regression, and advanced analytical techniques using modern tools.
3	To impart knowledge of cloud analytics platforms, ethical practices, and emerging trends in analytics for real-world data-driven decision making.
Course Outcomes: Learners will be able to	
1	Apply basic statistical methods and analytics concepts to summarize and interpret data.
2	Perform exploratory data analysis to identify patterns, outliers, and relationships in datasets.
3	Create effective static and interactive data visualizations for meaningful communication
4	Implement and evaluate regression models for predictive data analysis
5	Apply time series, text, and sentiment analysis for advanced data insights.
6	Demonstrate awareness of cloud-based analytics, ethical practices, and emerging trends in analytics.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Data Analytics and Statistical Foundations**	06	CO1
	1.1 Data Analytics :Key Roles for a Successful Analytics Process and Lifecycle, Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive		
	1.2 Statistical Foundations for Analytics: Mean, Median, Mode, Variance, Standard Deviation Correlation and Covariance Probability Basics and Distributions (Normal, Binomial) **Numericals:** Mean, variance, correlation coefficient, z-score, probability problems		
	Self Learning Topic: Explore a real dataset (e.g., sales, customer, or		

	stock data) to compute mean, median, variance, correlation, and basic probability using Python.		
02	**Exploratory Data Analysis (EDA) and Inferential Statistics** 2.1 Exploratory Data Analysis Process, Univariate, Bivariate, and Multivariate Analysis, Detecting Outliers and Data Patterns 2.2 Feature Relationships and Correlation Heatmaps Using Python for EDA (pandas, seaborn, matplotlib), Case Study: Customer Segmentation using EDA **Self Learning Topic:** Perform EDA on public datasets (Kaggle/UCI) using Python (pandas, seaborn, matplotlib) to identify patterns, correlations, and outliers.	07	**CO2**
03	**Data Visualization Principles and Tools** 3.1 Fundamentals and Design Principles of Visualization, Different Python and R libraries for visualization 3.2 Choosing the Right Chart Type, Static Visualizations (Matplotlib, Seaborn), Interactive Visualizations (Plotly, Dash, Tableau, Power BI), 3.3 Storytelling with Data and Dashboards, Principles of Effective Communication through Visuals **Self Learning Topic:** Create interactive dashboards using free tools: Tableau Public, Power BI Desktop, or Plotly Dash.	08	**CO3**
04	**Analytics using Regression Models** 4.1 Concept of Regression and Its Role in Data Analytics, Simple Linear Regression, Multiple linear regression, Polynomial Regression, Ridge Regression and Logistic regression .	07	**CO4**
	4.2.Model Evaluation Metrics: MAE, MSE, R^2,Adjusted R^2, Case Study: Predicting Sales or Revenue using Regression		
	Self Learning Topic: Fit a simple linear regression model using Python and interpret slope, intercept, and error metrics (MAE, RMSE).		
05	**Advanced Analytics and Applications** 5.1 Time Series Analysis and Forecasting Concepts:,Autoregressive Models ,Moving Average Models ,ARMA and ARIMA Models 5.2 Text Analytics Fundamentals: Text Preprocessing and Bag-of-Words (BoW) **5.3** Sentiment and Text Analytics: Text Analysis Steps , Term Frequency—Inverse Document Frequency (TFIDF),Categorizing Documents by Topics, Determining Sentiments , Gaining Insights Case Study: Sales Forecasting or Social Media Sentiment Analysis **Self Learning Topic:** Explore a small business problem: social media sentiment analysis to measure customer feedback or product perception.	08	**CO5**
06	**Cloud, Ethics, and Emerging Trends in Analytics** 6.1 Cloud-based Data Analytics Platforms: Google BigQuery, AWS, QuickSight, Power BI Cloud, Real-Time Analytics and Streaming Dashboards	06	**CO6**

	6.2 Augmented Analytics and AI-assisted Visualization Ethical and Privacy Issues in Data Usage, Data Governance and Responsible AI in Analytics, Industry Trends: Generative Analytics, Visual AI, Data Democratization		

Text Books:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data,EMC Education services Wiley Publication
2. Data Analytics using Python: Bharati Motwani, Wiley Publications.
3. Practical Text Mining and statistical Analysis for non-structured text data applications,1st edition,Grey Miner,Thomas Hill.
4. Wes McKinney, *Python for Data Analysis*, 3rd Edition, O'Reilly Media.

References:

1. Python for Data Analysis: 3rd Edition, Wes McKinney ,Publisher(s): O'Reilly Media, Inc
2. Data Mining, Concepts and Techniques: 3rd edition, Jiawei Han, Micheline Kamber and Jian Pei
3. https://nptel.ac.in/courses/106106212
4. https://nptel.ac.in/courses/110101438
5. https://www.youtube.com/watch?v=OumgFnQE5dE

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
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3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

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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
AIPEC 6023	**Game Theory**	20	20	60	1	2	100	

Prerequisite: Discrete Mathematics, Algorithms and Data Structures,Artificial Intelligence	
Course Objectives: The course aims to	
1	Build a rigorous foundation of non-cooperative and cooperative game theory for engineering and CS problems.
2	Equip students to model real markets/platforms (ad auctions, ride-sharing, fintech/DeFi, gig platforms) using game-theoretic tools.
3	Develop implementation skills for mechanism design, auctions, and multi-agent learning using modern open-source stacks.
4	Cultivate the ability to critique and tune incentive mechanisms for fairness, privacy, and robustness in production systems.
Course Outcomes: Learners will be able to	
1	Model strategic interactions as normal/extensive-form or Bayesian games and identify appropriate solution concepts.
2	Compute/verify equilibria (Nash, subgame-perfect, correlated) in small to medium games using analytical and algorithmic methods.
3	Design simple mechanisms/auctions (e.g., VCG, GSP, AMMs) that meet efficiency/truthfulness objectives under constraints.
4	Implement and evaluate multi-agent learning (bandits, MARL) for pricing, bidding, and routing problems.
5	Assess strategic behavior, collusion risks, and fairness/privacy impacts in digital platforms and marketplaces.
6	Apply game-theoretic ideas to a mini-project using real or synthetic data and communicate findings effectively.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundations of Game Theory** Introduction to strategic interaction and decision-theory basics, Normal-form games: players, strategies, payoff functions, Utility representation and payoff matrix analysis, Dominant, weakly dominant and dominated strategies, Best-response strategies and iterative elimination, Mixed strategies and mixed-strategy Nash equilibrium, Extensive-form games, game tree representation,	06	**CO1**

	backward induction		
	Self Learning Topic: Prisoner's dilemma in real-world scenarios (privacy, business strategy)		
02	**Nash Equilibrium & Refinements**	08	**CO2**
	Nash equilibrium: definition, existence (conceptual understanding), Mixed-strategy Nash equilibrium and support enumeration, Subgame perfect equilibrium via backward induction, Perfect, sequential, and trembling-hand refinements (conceptual), Repeated games: strategies, trigger strategies, folk theorem (intuitive), Correlated equilibrium; relation to no-regret learning, Basic introduction to computational methods: best-response dynamics, Lemke–Howson approach (conceptual)		
	Self Learning Topic: Real-world examples: oligopoly pricing, cartel formation		
03	**Bayesian Games & Mechanism Design**	08	**CO3**
	Games with incomplete information: Bayesian games, types, beliefs, Bayes–Nash equilibrium definitions and examples, Mechanism design foundations: incentive compatibility (IC) and individual rationality (IR), Revelation principle – conceptual treatment, Auction theory: first price, second price (Vickrey), VCG mechanism, Generalized Second Price (GSP) auction for online advertising, Revenue maximization, reserve prices, bidding strategies, Matching markets: stable matching, Gale–Shapley algorithm (conceptual & examples)		
	Self Learning Topic: Impact of fraud and click-spam on auction dynamics		
04	**Algorithmic & Learning Approaches in Games**	07	**CO4**
	Regret minimization fundamentals, Multi-armed bandit algorithms: ε-greedy, Thompson sampling, Contextual bandits for ad-selection, recommendation, personalization, Learning in strategic environments; no-regret → correlated equilibrium, Multi-Agent Reinforcement Learning (MARL), Equilibrium convergence in learning systems, Industrial applications: dynamic pricing, automated bidding, adaptive policies		
	Self Learning Topic: Fairness-aware bandit algorithms		
05	**Platform Economics & Industrial Game Theory**	07	**CO5**
	Overview of real-world platform incentive systems, Ad-auction markets: GSP, automated bidding, pacing, bid-shading, Surge pricing in ride-sharing: dynamic supply-demand games, Game-theoretic models for delivery platforms, gig-economy incentives, Security, fairness, and transparency considerations, Rating, ranking, and reputation systems as games, (Miner Extractable Value) as strategic behavior.		

	Self Learning Topic: Incentive structures in gig economy (Zomato/Swiggy/Deliveroo)		
06	**Network Games, Mean-Field Games & Security** Network and congestion games: routing, potential games, Congestion equilibria and Braess paradox, Potential functions and convergence, Mean-field games: modeling large populations, Stackelberg leadership model: defender–attacker games, Security games: patrolling, defense resource allocation, Applications: cybersecurity, cloud resource allocation, fraud prevention **Self Learning Topic:** Game theory in biological or ecological systems	06	**CO6**

Text Books:

1. Osborne, Martin J. & Rubinstein, Ariel. *A Course in Game Theory*. MIT Press.
2. Nisan, Noam; Roughgarden, Tim; Tardos, Éva; Vazirani, Vijay. Algorithmic Game Theory. Cambridge University Press.
3. Myerson, Roger B. *Game Theory: Analysis of Conflict*. Harvard University Press.

References:

1. Krishna, Vijay. *Auction Theory*. Academic Press.
2. Shoham, Yoav & Leyton-Brown, Kevin. *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*.
3. Easley, David & Kleinberg, Jon. *Networks, Crowds, and Markets*. Cambridge University Press.
4. Tambe, Milind. *Security and Game Theory: Algorithms, Deployed Systems, Lessons Learned*. Cambridge University Press.
5. Varian, Hal R. *Intermediate Microeconomics: A Modern Approach*. W.W. Norton.
6. https://nptel.ac.in/courses/110104063

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
AIPEC 6024	**Drone Technology**	20	20	60	1	2	100	

Prerequisite: IoT and Cloud Computing	
Course Objectives: The course aims to	
1	To introduce students to the fundamentals of Unmanned Aerial Vehicles (UAVs) and drones
2	Develop understanding of drone design, hardware architecture, sensors, and programming fundamentals.
3	Apply Artificial Intelligence and Machine Learning techniques in drone navigation, sensing, and data analysis.
4	To familiarize students with the current technologies and regulatory environment in drone development and operation.
Course Outcomes: Learners will be able to	
1	Explain the basic concepts, types, and components of drones along with their evolution and terminology.
2	Understand and Illustrate drone design principles and identify suitable software and hardware components.
3	Demonstrate programming skills using embedded systems, sensors, and autopilot platforms for drone operation.
4	Operate and manage drone systems effectively using onboard sensors, flight modes, and control interfaces.
5	Apply AI and ML techniques for perception, navigation, decision-making, and predictive maintenance in drones.
6	Explore safety measures, regulatory frameworks,future developments, real-world applications and challenges in drone deployment.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Drones** 1.1 Introduction to Drone Technology: Concepts, Terminology, History and Evolution of Drones, Features, Components, Architecture and Classification of Drones 1.2 Types of Current Generation Drones and Applications in Agriculture, Surveillance, Delivery, Inspection and Defense 1.3 Drone Ecosystem and Emerging Opportunities in Industry	6	**CO1**

	Self Learning Topic: Regulations and Guidelines for drone usage.		
02	**Drone Design** 2.1 Design Considerations for Drones, Drone Hardware Components, Selection and Assembly of Motors, Batteries, Flight Controllers, Propellers and Cameras 2.2 Flight Control Hardware, General Architecture of Drone Systems and Drone System Functions 2.3 Embedded Systems and Sensors in Drones: IMU, GPS, Barometer, Magnetometer, Communication Systems and Telemetry **Self Learning Topic: DIY Drone Building Tutorials using Open-Source Platforms**	7	**CO2**
03	**Drone programming** 3.1 Introduction to Programming Languages for Drones: C and Python, Embedded Programming Concepts and Installation/Configuration of Controller Boards 3.2 Flight Controllers and Autopilot Systems: Pixhawk, ArduPilot and PX4, Firmware Installation and Configuration 3.3 Mission Planning and Simulation Tools: Mission Planner, QGroundControl, DroneKit-Python, ROS, AirSim, Gazebo and PX4 SITL **Self Learning Topic: Introduction to DroneKit-Python or ROS (Robot Operating System),Simulation Tools – AirSim, Gazebo, and PX4 SITL**	8	**CO3**
04	**Drone Operations** 4.1 Concepts of Drone Operations, Flight Modes, Navigation and Flight Controls 4.2 Drone Flight Operations in Controlled Environments, Mission Planning, Monitoring and Management 4.3 Sensors, Onboard Storage Capacity, Removable Storage Devices, Linked Mobile Devices and Applications	7	**CO4**
05	**AI in Drone Technology** 5.1 Introduction to AI Integration in Drones, Perception and Sensing, Computer Vision, Object Detection and Environmental Awareness 5.2 Autonomous Navigation, Path Planning, Decision-Making Systems and Intelligent Mission Planning 5.3 Predictive Analytics, Predictive Maintenance and AI Applications in Drone Technology **Self Learning Topic:** **Case Study: AI in Drone Delivery (Amazon Prime Air, Zipline)**	8	**CO5**
06	**Future Drones And Safety** 6.1 Drone Regulations and Safety: DGCA Regulations in India, Airspace Classification, Safety Protocols and Fail-Safe Mechanisms 6.2 Applications of Drones in Agriculture, Surveillance, Delivery, Inspection, Defense and Smart Cities	6	**CO6**

	6.3 Emerging Trends in Drone Technology: Swarm Drones, AI Integration, BVLOS Operations, Additive Manufacturing for UAV Components, Green Drones, Renewable Energy and Solar Power Integration, Urban Air Mobility and Air Taxis Cybersecurity Challenges in UAV Systems		
	Self Learning Topic: Cybersecurity Challenges in UAV Systems Green Drones – Renewable Energy and Solar Power Integration Industry Trends: Urban Air Mobility and Air Taxis		

Text Books:

1. Dr. Subhash K. Shinde, Dr. Jyoti Sunil More, Dr. Chaitrali Prasanna Chaudhari by Drone Technology with AI : A Comprehensive Guide to Drone Operations and Techniques (English Edition)

2. Paul G. Fahlstrom, Thomas J. Gleason, and Mohammed H. Sadraey, Introduction to UAV Systems, John Wiley & Sons, Inc. , 5th edition, 2022

3. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.

4. Austin, R, Unmanned Aircraft Systems: UAVS Design, Development and Deployment, John Wiley & Sons Ltd

References:

1. Sachi Nandan Mohanty, J.V.R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen"Drone Technology: Future Trends and Practical Applications"Print ISBN:9781394166534 |Online ISBN:9781394168002 |DOI:10.1002/9781394168002© 2023 Scrivener Publishing LLC
2. Drone Systems and Applications, Elsevier
3. Drone Systems and Control

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/case study: 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
CEMDM 601	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** 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 Application	2	CO1
02	**Hadoop** Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	6	CO2
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** 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 .	**6**	**CO4**
05	**Techniques in Big Data Analytics** 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	**14**	**CO5**
06	**Big Data Analytics Applications** 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.	**7**	**CO6**

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
ETMDM 601	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 the 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.	09	CO2

	Spatial filtering – Smoothing, Sharpening, Highboost and Median Filters. Frequency domain enhancement techniques - Introduction to 2-D DFT and 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:

1. Kenneth R. Castleman, Digital Image Processing, Pearson, 1996.
2. B. Chanda and D. Dutta Majumder, Digital Image Processing and Analysis, PHI, 2011.
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, “Digital Image Processing”, Third Edition, Tata McGraw Hill Education Private Ltd, 2009
4. 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	

Course Objectives: The course aims to	
1	To acquaint with significance of robotic systems in agile and automated manufacturing processes.
2	To make conversant with robotic elements/ peripherals, their selection and interface with manufacturing equipments
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://online**courses**.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)

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
ITMDM 601	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	9	CO2

	programs. (Assembly programs are restricted to basic arithmetic, logical and data transfer operations only)		
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:-

- Han Way Huang, "PIC Microcontroller: An Introduction to Software and Hardware Interfacing", Cengage Learning, 2005.
- 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/
- https://www.arduino.cc/education/certification/

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	

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 Final drive gears & bearings 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)

1. Assignment: 5 Marks
2. Quiz/Visit/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
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** a. Basics of vehicle mechanisms, history of Electric vehicles (EV) and hybrid electric vehicles (HEV), importance of EV and HEV. b. Power/Energy supplies requirements for EV/HEV applications, transmission characteristics. c. State of the art and Indian and global scenario in EV/HEV.	07	CO1

	Self Learning Topic: Basics of vehicle parts, Bharat standard for vehicle emission.		
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 2.3 fuel efficiency analysis for series and hybrid drive train, comparison. **Self Learning Topic: Electric motor, single and multi drive system,**	**07**	**CO2**
03	**DC and AC machines and Drives for propulsion application** 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.**	**07**	**CO3**
04	**Energy sources for EV and HEV** 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.**	**07**	**CO4**
05	**Drive train modeling in EV/HEV** 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.**	**07**	**CO5**
06	**Energy management strategies in EV/HEV** 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.**	**07**	**CO6**

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

NPTEL/ Swayam Course:

1. Course: Intro. to Hybrid and Electric Vehicles - Prof. Praveen Kumar & Prof. S. Majhi (IIT Guwahati): https://nptel.ac.in/courses/108/103/108103009/
2. Course: Electric Vehicles - Part 1 By Prof. Amit Kumar Jain (IIT Delhi) https://nptel.ac.in/courses/108/102/108102121/

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 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
AIPCL601	Deep Learning Lab	-	25	25	-	-	50	

Prerequisite: Python Programming	
Course Objectives: The lab course aims to	
1	Implement basic neural network models.
2	Implement various training algorithms for feedforward neural networks.
3	Design and evaluate deep learning models for supervised learning.
4	Implement deep learning models for unsupervised learning.
5	Design deep learning models for sequence learning.
	Design and implement Transformer-based models for modern AI applications.
Course Outcomes: Learners will be able to	
1	Implement basic neural network models.
2	Design and train feedforward neural networks using various learning algorithms and optimize model performance.
3	Build and train Autoencoder model
4	Build and train CNN model
5	Build and train RNN model
6	Build and implement Transformer-based models for sequence and language processing applications.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To explore python libraries for deep learning e.g. Theano, TensorFlow etc.	1
02	Implement Multilayer Perceptron algorithm to simulate XOR gate.	1
03	Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers.	2
04	Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function.	2

05	Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. Adam Learning GD	2
06	Design the architecture and implement the autoencoder model for Image Compression.	3
07	Design the architecture and implement the autoencoder model for Image denoising.	3
08	Design and implement a CNN model for digit recognition application.	4
09	Design and implement a CNN model for image classification.	4
10	Design and implement LSTM model for handwriting recognition, speech recognition, machine translation, speech activity detection, robot control, video games, time series forecasting etc.	5
11	Design and implement GRU for any real life applications, chat bots etc.	5
12	Design and implement RNN for classification of temporal data , sequence to sequence data modelling etc.	5
13	Design and implement a Transformer-based model for text classification or sequence prediction applications.	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

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)					
AIPCL602	**Software Engineering and Project Management Lab**	-	25	25	-	-	50	1

Prerequisite: Basic programming knowledge, OOPs concept.	
Course Objectives: The lab course aims to	
1	Understand fundamental software engineering concepts, software development processes, and Agile methodologies.
2	Analyze and document software requirements using standard modeling and documentation techniques.
3	Apply software estimation, project planning, and version control techniques for effective software development.
4	Perform software testing, risk management, and Agile project management practices to improve software quality and reliability.
Course Outcomes: Learners will be able to	
1	Prepare Software Requirement Specification (SRS) documents using standard documentation practices.
2	Develop DFD and UML diagrams for representing software systems and workflows.
3	Apply software estimation, project planning, scheduling, and project management techniques using appropriate tools.
4	Design test cases and perform software quality and risk analysis activities.
5	Use version control and automated testing tools for software development and maintenance.
6	Develop mini-projects by integrating SDLC phases, Agile practices, and project documentation.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Prepare an SRS for a sample software application.	01
02	Draw DFD and UML diagrams for the given case study.	02
03	Create Use Case, Class, and Sequence diagrams for a simple application using StarUML or Lucidchart.	02
04	Develop a project plan using Work Breakdown Structure (WBS).	03
05	Perform software cost estimation using COCOMO Model.	03
06	Prepare Gantt and PERT charts using project management tools.	03
07	Perform risk analysis for a project.	04
08	Create test cases for black-box and white-box testing.	04
09	Identify and document software risks with mitigation strategies for a given case study.	04
10	Create and execute unit test cases using JUnit for a simple application module.	05
11	Demonstrate version control using Git.	05
12	Demonstrate Agile workflow using Jira/Trello.	06
13	Mini-Project covering SDLC phases and documentation.	06

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
AIPEL 6011	**Cryptography and System Security Lab**	-	25	-	-	-	25	

Prerequisite: Programming knowledge	
Course Objectives: The lab course aims to	
1	Apply the knowledge of symmetric cryptography to implement classical and modern ciphers.
2	To analyze and implement public key algorithms like RSA, ElGamal, and Diffie–Hellman key exchange.
3	To analyze and evaluate performance of hashing and message authentication algorithms.
4	To explore various authentication and digital signature mechanisms practically.
5	To study operating system and database security tools and protection techniques.
6	To explore and use different web and network security tools for scanning, sniffing, intrusion detection, and email security.
Course Outcomes: Learners will be able to	
1	Apply the knowledge of symmetric cryptography to design and implement simple substitution and transposition ciphers.
2	Analyze and implement public key algorithms like RSA, ElGamal, and Diffie–Hellman.
3	Analyze and evaluate performance of hashing and message authentication algorithms such as MD5, SHA, and HMAC.
4	Demonstrate the use of digital signatures and certificate-based authentication mechanisms
5	Use tools like sniffers, port scanners, and other related tools for analyzing packets and services in a network.
6	Apply and set up firewalls, intrusion detection systems, and explore email and web security using open-source technologies.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Design and Implementation of a product cipher using Substitution and Transposition ciphers.	1
02	Implementation of **AES and DES** algorithms in various modes (ECB, CBC, CTR, GCM) and comparison of security features.	1
03	Implementation of Diffie–Hellman Key Exchange Algorithm and demonstration of shared key generation.	2
04	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.	3
05	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.	4
06	Exploring wireless security tools like Kismet, NetStumbler etc.	5
07	Study the use of network reconnaissance tools like WHOIS, dig,traceroute, nslookup to gather information about networks and domain registrars.	5
08	Study of packet sniffer tools wireshark, :- 1. Observer performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters.	5
09	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc.	5
10	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark	5
11	Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities	5
12	Set up IPSEC under LINUX. b) Set up Snort and study the logs. c) Explore the GPG tool of linux to implement email security.	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					Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	Exam Duration (Hrs)			Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)		MSE	ESE		1
AIPEL 6012	Natural Language Processing Lab	-	25	-	-	-	25	

Prerequisite: Python Programming	
Course Objectives: The lab course aims to	
1	Understand the fundamental concepts and applications of Natural Language Processing (NLP) and identify suitable problem statements for real-world NLP-based mini projects.
2	Apply text preprocessing techniques such as tokenization, filtration, stop word removal, lemmatization, and stemming to prepare textual data for analysis and model development.
3	Analyze the morphological and syntactic structures of text using techniques such as morphological analysis, Part-of-Speech (POS) tagging, and chunking.
4	Implement language modeling and feature extraction methods like N-Gram models, Named Entity Recognition (NER), and Text Similarity measures for understanding contextual relationships in text.
5	Explore and apply advanced NLP techniques such as word sense disambiguation using deep learning models (LSTM/GRU) and visualization methods like word clouds for exploratory data analysis.
6	Design, develop, and present a mini project based on a chosen real-world NLP application (e.g., Chatbot, Sentiment Analysis, Machine Translation, etc.) integrating the studied techniques and tools.
Course Outcomes: Learners will be able to	
1	Demonstrate an understanding of various NLP applications and the ability to formulate a well-defined problem statement for a real-world NLP project.
2	Preprocess and clean text data efficiently using tokenization, stop word removal, lemmatization/stemming, and other preprocessing techniques for model-ready input.
3	Perform morphological and syntactic text analysis by implementing POS tagging and chunking to extract linguistic structures from raw text.
4	Develop and apply statistical and deep learning-based NLP models such as N-Gram models, NER systems, and word sense disambiguation using LSTM/GRU.
5	Evaluate and compare text similarity and semantic relationships between documents using appropriate similarity measures and models.
6	Design and implement an end-to-end NLP mini project demonstrating the integration of preprocessing, modeling, and visualization for real-world problem-solving and presentation.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, Chat Bot, Plagiarism, Spelling & Grammar Checkers, Sentiment / Opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]	1
02	Apply various text preprocessing techniques for any given text: Tokenization and Filtration & Script Validation	2
03	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming	2
04	Perform morphological analysis and word generation for any given text	3
05	Implement N-Gram model for the given text input	4
06	Study the different POS taggers and Perform POS tagging on the given text	3
07	Perform chunking by analyzing the importance of selecting proper features for training a model and size of training	3
08	Implement Named Entity Recognizer for the given text input	4
09	Implement Text Similarity Recognizer for the chosen text documents	5
10	Implement word sense disambiguation using LSTM/GRU	5
11	Exploratory data analysis of a given text (Word Cloud)	5
12	Mini Project Report: On real world NLP application	6
13	Implementation and Presentation of Mini Project	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
AIPEL 6013	**Nature Inspired Computing Lab**	-	25	-	-	-	25	

Prerequisite: Algorithms and Programming Logic	
Course Objectives: The lab course aims to	
1	To understand and implement the fundamental computational principles inspired by natural and biological systems.
2	To apply and analyze evolutionary algorithms and swarm intelligence techniques to solve real-world optimization problems.
3	To design and evaluate hybrid and adaptive algorithms based on concepts of self-organization, emergence, and adaptation.
4	To develop and test computational models inspired by biological immune systems for pattern recognition and anomaly detection.
Course Outcomes: Learners will be able to	
1	Implement basic local search algorithms such as Hill Climbing and Simulated Annealing for optimization problems.
2	Design and apply Evolutionary Algorithms (Genetic Algorithms, Evolutionary Programming, Genetic Programming) to benchmark functions.
3	Examine and compare the working principles of Swarm Intelligence algorithms such as ACO and PSO through simulation and performance evaluation.
4	Develop hybrid and adaptive evolutionary systems for improved optimization performance.
5	Implement Artificial Immune System models for anomaly detection and pattern recognition tasks.
6	Analyze, evaluate, and interpret the effectiveness of different nature-inspired algorithms for real-world engineering and optimization problems.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Benchmarking Local Search: Hill Climbing vs Simulated Annealing (SA). Implement and compare both algorithms on benchmark functions (Sphere, Rastrigin, Rosenbrock).	1,6
02	Implementation of Genetic Algorithm (GA) : Apply GA for solving single-objective optimization problems and analyze the effect of crossover and mutation rates.	2,6
03	Evolutionary Programming (EP) for Function Optimization : Implement EP and compare results with GA.	2,6
04	Genetic Programming (GP) for Symbolic Regression : Genetic Programming (GP) for Symbolic Regression	2,6
05	Hybrid Evolutionary Algorithm (GA + SA or GA + PSO): Combine two optimization methods and analyze performance improvements.	2,6
06	Ant Colony Optimization (ACO) for the Traveling Salesman Problem (TSP) : Implement ACO and visualize pheromone updates and convergence.	3,6
07	Particle Swarm Optimization (PSO) for Benchmark Functions : Implement PSO and analyze parameter influence on convergence.	3,6
08	Simulation of Swarm Robotics / Foraging Behavior : Model collective behavior using simple agents to demonstrate emergence and adaptation.	3,6
09	Artificial Immune System (AIS) for Anomaly Detection: Implement negative selection algorithm for detecting abnormal data patterns.	5,6
10	Danger Theory / Immune Network Algorithm : Apply immune network model for pattern classification and compare with machine learning baselines.	5,6

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
AIPEL 6014	Augmented Reality and Virtual Reality Lab	-	25	-	-	-	25	

Prerequisite: Mathematics, Programming logic, Machine learning	
Course Objectives: The lab course aims to	
1	To understand the fundamental concepts, tools, and frameworks used for developing Virtual and Augmented Reality applications.
2	To design and implement interactive 3D environments and AR/VR experiences using open-source platforms
Course Outcomes: Learners will be able to	
1	Create and manipulate 3D virtual environments using open-source tools.
2	Integrate interaction techniques and sensors to enhance immersion in VR/AR applications.
3	Develop simple augmented reality applications using marker-based or markerless tracking.
4	Demonstrate creativity and technical proficiency in building immersive prototypes.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	To study and install open-source VR/AR development tools (Unity, Blender, AR.js).	1
02	To create and visualize basic 3D objects and environments in Blender.	1
03	To import 3D models from Blender into Unity and set up a simple virtual environment.	1,4
04	To implement navigation and interaction controls in a VR scene (camera, movement, rotation).	2
05	To apply lighting, textures, and materials for realism in a virtual environment.	1,4
06	To design a virtual walkthrough (e.g., campus or room tour) using Unity.	1,2,4
07	To create a marker-based AR application using AR.js or Vuforia.	3
08	To overlay 3D objects on real-world markers using webcam or mobile camera.	3
09	To develop a simple markerless AR app using GPS or image recognition.	3,4
10	To integrate user interactions (touch, gestures, or voice) in AR/VR environments.	2,4
11	To create a mini project combining VR/AR features for a real-world application (education, tourism, healthcare, etc.).	1,2,3,4

12	To present and demonstrate the final immersive application prototype with documentation.	4

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
CEMD ML601	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	1
02	Programming exercises on Hadoop Using Hive, Pig, Hbase,Sqoop NOSQL, MongoDB	2
03	Implementing simple algorithms in MapReduce Matrix,multiplication, Aggregates, joins, sorting, searching etc.	3
04	Implementing Algorithms using MapReduce (Any 2)	3
05	Implementing Frequent Item set Mining	4
06	Implementing Clustering algorithms Implementing Classification Algorithms	5
07	Big Data Applications (Any 2) ● Implementing Analytics on data streams ● Implementing Social Network Analysis Algorithms	6
08	Implementing Web Graph Algorithms Implementing recommendation Engines	6
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)	5,6

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

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

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
ETMD ML601	Digital Image Processing Lab	-	25	-	-	-	25	

Prerequisite: Python Programming Skill Lab	
Course Objectives: The lab 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	1
02	Perform Image transformations like rotation, scaling, and translation	1
03	Implement Histogram equalization	2
04	Implement Spatial Domain Filtering: Smoothing and Sharpening Filters	2
05	Implement Frequency domain filtering: Low-pass and High-pass Filters	2
06	Implement Edge based segmentation- Sobel, Prewitt, Laplacian, and Canny operators	3
07	Implement region growing and watershed segmentation	3
08	Image segmentation using global Thresholding Algorithm	3
09	Implement RLE and Huffman coding for images	4
10	Implement Discrete Cosine Transform	4

11	Implement Wavelet transform	4
12	Implement Morphological operation – Erosion and Dilation, Opening and Closing operations, Hit-or-Miss transform, Boundary Extraction and Region Filling, Thinning and Thickening	5
13	Compute region and shape descriptors for given images	5
14	Perform object detection	6
15	Case Study on applications of Image Processing	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
ARMD ML601	Robotics Lab	-	25	-	-	-	25	

Prerequisite:	
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 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.	1
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.	2
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	3
03	Edge detection using image processing (simulation/hardware)Result: Edges in the image successfully detected using gradient-based algorithms.	4
04	Segmentation using image processing (simulation/hardware)	5
05	Trajectory Generation and Path Planning(simulation/hardware)	6
06	Programming the robots to solve direct and inverse kinematics problems	7
06	Acquisition of sensor data over cloud using microcontroller (simulation/hardware)	5
07	Implementation of Clustering algorithm (K-means / K-medoids)	6
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.	1,4

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

Continuous Internal Evaluation (25 Marks)

5. Lab Performance: 10 Marks
6. In-Semester Practical Exam during lab session: 10 Marks
7. 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 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	1,2
Group B	1. Square wave generation 2. LED inter facing 3. Blinking LED 4. Serial port programming 5. Counter programming	3
Group C	1. Simple arduino programming for addition subtraction	4
Group D	1. Arduino programming for LED blinking 2. PIC 18 programming for LCD interface 3. PIC 18/Arduino programming for DC motor interface 4. Any other application of Microcontroller	5 6

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. Mid Semester Oral & 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
MEMDML 601	Automobile Lab	-	25	-	-	-	25	

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.	1
02	Comparative study of manual (synchromesh) and automatic transmission (torque converter / CVT).	1
03	Study and demonstration of propeller shaft, universal joint, and differential gear using cut section models.	2
04	Demonstration of suspension systems.	3
05	Analysis of chassis frames (ladder, monocoque, space-frame) and vehicle layout identification.	4
06	Study of EV architecture – components like battery, motor, inverter, and charging systems.	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
EEMD M601	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	1
02	Study of transmission system through simulation/ experiment	1
03	Emission test of conventional vehicle, electric vehicle and hybrid electric vehicle	2
04	Develop schematic diagram of hybrid electric vehicle and identify its parts in matlab simulation	2
05	Load test of DC series Motor	3
06	Testing and analysis of induction motor loading at different speed and torque conditions.	3
07	Connect and run the three phase squirrel cage induction motors (in both directions) using the DOL starter/ autotransformer starter.	3
08	Rechargeable lithium-ion battery SOC test and other performance	4
09	Design and testing of controlled rectifier circuit for battery charging	4
10	Prepare a report on batteries used from market survey	4
11	study of battery management system through simulation/experiment	5
12	Design and testing of battery connected buck / boost converter	5
13	List safety procedures and schedule for handling HEVs and EVs	6
14	Case study- Compare minimum four vehicles for economic and environmental analysis	6
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
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
AICEP601	Mini Project II	-	25	25	-	-	50	

Course Objectives: The course aims to	
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 and modern tools & techniques 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 for Mini Project	
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/
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https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/ai-project-ideas
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