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 Engineering

CURRICULUM STRUCTURE

For

THIRD YEAR ENGINEERING

(BASED ON NEP 2020)

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

Approved by Board of Studies on 30/04/2026

Approved by Academic Council on 22/05/2026

Department of Computer 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 Honours 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. Sheeba P. S.	**Dr. Sheeba P. S.**	**Dr. Subhash K. Shinde**
BoS Chairperson, CE	**Dean, Academics & Research**	**Principal**

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

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

Definition of Credit:

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

Credit Requirements for Award of Degree:

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

b) A student shall be eligible for the award of an **Undergraduate Degree** with **Honours/Minor** in Emerging Areas upon earning an additional **18 credits**.

Multiple Exits:

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

Distribution of Credits:

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

Type of Course	Course Code	No. of Credits as per Maharashtra Govt.	No. of credits as per LTCE
Basic Science Course	BSC	14-18	**16**
Engineering Science Course	ESC	12-16	**14**
Programme Core Course	PCC	44-56	**49**
Programme Elective Course	PEC	20	**19**
Multidisciplinary Minor	MDM	14	**14**
Open Elective (OE) Other 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+ Honours/ Minors)		**178-194**	**167+18=185**

Abbreviations:

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

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

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Department of Computer Engineering

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)		
CEPCC501	Theory of Computation	3	-	3	-	3	20	20	60	2	-	100
CEPCC502	Machine Learning	3	-	3	-	3	20	20	60	2	-	100
CEPCC503	Computer Network	3	-	3	-	3	20	20	60	2	-	100
CEPEC501	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
CEVSEC501	Computational Lab	-	2*+2	-	2	2	-	50	-	-	25	75
CEPCL501	Machine Learning Lab	-	2	-	1	1	-	25	-	-	25	50
CEPCL502	Computer Network Lab	-	2	-	1	1	-	25	-	-	25	50
CEPEL501x	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

CEPEC501x: Program Elective Course I	**CEPEC5011** Natural Language Processing	**CEPEC5012** Soft Computing	**CEPEC5013** Image Generation and Rendering	**CEPEC5014** Big Data Analytics
CEPEL501x: Program Elective Lab I	**CEPEL5011** Natural Language Processing Lab	**CEPEL5012** Soft Computing Lab	**CEPEL5013** Image Generation and Rendering Lab	**CEPEL5014** Big Data Analytics Lab

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Department of Computer Engineering

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)		
CEPCC601	Software Engineering	3	-	3	-	3	20	20	60	2	-	100
CEPCC602	System Software & Compiler Design	3	-	3	-	3	20	20	60	2	-	100
CEPEC601x	Program Elective Course II	3	-	3	-	3	20	20	60	2	-	100
CEPEC602x	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
CEPCL601	Software Engineering Lab	-	2	-	1	1	-	25	-	-	25	50
CEPCL602	System Software & Compiler Design Lab	-	2	-	1	1	-	25	-	-	25	50
CEPEL601x	Program Elective Lab II	-	2	-	1	1	-	25	-	-	-	25
XXMDML601	Multidisciplinary Minor Lab III	-	2	-	1	1	-	25	-	-	-	25
CECEP601	Mini Project II	-	2	-	1	1	-	25	-	-	25	50
Total		**15**	**10**	**15**	**5**	**20**	**100**	**225**	**300**	**10**	**75**	**700**

CEPEC601x: Program Elective Course II	**CEPEC6011** Internet of Things	**CEPEC6012** Wireless Network	**CEPEC6013** Augmented and Virtual Reality	**CEPEC6014** Data Science & Visualization
CEPEL601x: Program Elective Lab II	**CEPEL6011** Internet of Things Lab	**CEPEL6012** Wireless Network Lab	**CEPEL6013** Augmented and Virtual Reality Lab	**CEPEL6014** Data Science & Visualization Lab
CEPEC602x: Program Elective Course III	**CEPEC6021** Quantum Computing	**CEPEC6022** Human Machine Interaction	**CEPEC6023** Advance Algorithm & Complexity	**CEPEC6024** Social Media Analytics

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

Department of Computer Engineering

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
CEPCC501	Theory of Computation	20	20	60	1	2	100	

Prerequisite: Basic mathematical fundamentals: Sets, Logic, Relations, functions, Discrete Structure, Computer organization.	
Course Objectives: The course aims to	
1	Acquire conceptual understanding of fundamentals of Grammars and Languages.
2	Build concepts of theoretical design of deterministic and non-deterministic finite automata
3	To understand concept of RE and properties of RE to design Regular Languages
4	Build concepts of theoretical design of push down automata (PDA).
5	Develop understanding of different types of Turing machines and applications.
6	Understand the concept of Undecidability.
Course Outcomes: Learners will be able to	
1	Understand concepts of Theoretical Computer Science, difference and equivalence of DFA and NFA, languages described by finite automata and regular expressions.
2	Inferring the regular languages described by Regular Expressions.
3	Design regular languages, Context free Grammars, and recognizing the strings and tokens.
4	Design pushdown automata to recognize the language.
5	Develop an understanding of computation through Turing Machine.
6	Acquire fundamental understanding of decidability and undecidability.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction of basic Concepts and Finite Automata** Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM). Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε- transitions, NFA to DFA	09	**CO1**

	Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA. **Self-Learning Topics:** Binary number system, Set theory concepts, State elimination method for converting FA to RE. Minimization of DFA using equivalence theorem. Conversion of Moore to Mealy and vice versa.		
02	**Regular Expressions and Languages** Regular Expression (RE), Equivalence of RE and FA, Arden's Theorem, RE Applications Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs. **Self-Learning Topics:** Set theory laws, Applications of RL in Compiler design, Text processing, and NLP.	07	**CO2**
03	**Grammars** Grammars and Chomsky hierarchy 3.2 Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA. Context Free Grammars (CFG) Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties. **Self-Learning Topics:** Left recursion, Application of CFGs in XML, Parsing, and in NLP	08	**CO3**
04	**Pushdown Automata (PDA)** Definition, Language of PDA, PDA as generator, decider and acceptor of CFG, Deterministic PDA, Non-Deterministic PDA, Application of PDA. **Self-Learning Topics:** Top-down and Bottom-up parsing, Closure properties of PDA	04	**CO4**
05	**Turing Machine (TM)** Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs. **Self-Learning Topics:** Algorithms in TM, Linear Bounded Automata Model, Designing various TM.	07	**CO5**
06	**Undecidability** Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem. **Self-Learning Topics:** Np complete problems, NP completeness of SAT problems	02	**CO6**

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman**, "Introduction to Automata Theory, Languages and Computation"**, 3rd Edition, Pearson Education, 2008.
2. Michael Sipser, **"Theory of Computation"**, 3rd Edition, Cengage learning. 2013.
3. Vivek Kulkarni**, "Theory of Computation"**, Illustrated Edition, Oxford University Press, (12

April 2013) India

References:

1. J. C. Martin, **"Introduction to Languages and the Theory of Computation"**, 4 th Edition, Tata McGraw Hill Publication, 2013.
2. Kavi Mahesh, "Theory of Computation: A Problem-Solving Approach", Kindle Edition, Wiley-India, 2011.
3. https://nptel.ac.in/courses/106/104/106104028/
4. https://onlinecourses.nptel.ac.in/noc19_cs47/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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
CEPCC502	Machine Learning	20	20	60	1	2	100	

Prerequisite: Linear Algebra, Probability & Statistics, Python, DBMS	
Course Objectives: The course aims	
1	To introduce the fundamental concepts, scope and types of machine learning
2	To develop an understanding of the mathematical and statistical foundations of machine learning algorithms.
3	To enable learners to preprocess, analyze, and model data using appropriate learning techniques
4	To provide basic knowledge of Neural networks.
Course Outcomes: Learners will be able to:	
1	Demonstrate understanding of fundamental concepts and applications of Machine Learning.
2	Apply supervised learning algorithms to solve classification problems and evaluate their performance using appropriate metrics.
3	Implement and assess regression and ensemble learning techniques to enhance prediction accuracy and model robustness.
4	Analyze unsupervised learning algorithms and evaluate their effectiveness on real-world data.
5	Apply and analyze dimensionality reduction techniques to simplify high-dimensional datasets while preserving essential information.
6	Implement neural network models using appropriate activation and learning functions.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Machine Learning** Introduction, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application. Training Error, Generalization error, Overfitting, Underfitting, Bias-Variance trade-off. **Self-Learning Topics:** Role of feature engineering and data preprocessing in model performance	4	**CO1**
02	**Supervised Learning: Classification** Naïve Bayes, Decision Tree- information gain, entropy & Gini Index, Support Vector Machine, SVM as constrained optimization problem, Basics of Kernel trick, SVM for linear and nonlinear classification. Performance Metrics: Confusion Matrix, Sensitivity, Specificity,	9	**CO2**

	Precision, Recall, F measure, ROC curve		
	Self-Learning Topics: Case study: Classification of medical, financial, etc. datasets		
03	**Supervised Learning: Regression**	10	**CO3**
	Learning with Regression: Linear Regression, Logistic Regression. Ensemble Learning: Bagging, Boosting, K-fold cross validation, Random Forest, AdaBoost, Gradient Boost. Performance Metrics: MSE, RMSE, MAE, R^2		
	Self-Learning Topics: Regularization techniques: Ridge, Lasso, and Elastic Net Regression		
04	**Un Supervised Learning**	8	**CO4**
	Clustering: K means, K medoid, Hierarchical, DBSCAN Association Rule Mining- Apriori, FP Growth		
	Self-Learning Topics: Evaluation metrics for clustering, Graph Based Clustering**,** Gaussian Mixture Models		
05	**Dimensionality Reduction**	5	**CO5**
	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis		
	Self-Learning Topics: Singular Valued Decomposition, Visualization of high-dimensional data		
06	**Introduction to Neural Network**	6	**CO6**
	Biological Neural Network, Fundamentals of Artificial Neural Network, Basic Architecture of Neural Network for Perceptron, Single layer and Multi-Layer Neural Network, Activation functions, Backpropagation, Issues in neural network training.		
	Self-Learning Topics: Optimization algorithms		

Text Books:

1. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
2. Stephen Marsland, “Machine Learning An Algorithmic Perspective”, CRC Press
3. Peter Harrington, “Machine Learning in Action”, DreamTech Press
4. Tom M. Mitchell, “Machine Learning”, McGraw Hll
5. Charu C Aggarwal, Neural Network & Deep Learning A Textbook, Springer, 2018/2023

References:

1. Kevin P. Murphy, Machine Learning — A Probabilistic Perspective
2. Machine Learning for Absolute Beginners by Oliver Theobald
3. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists.
4. John D. Kelleher, Brian Mac Namee, and Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics.
5. Jiawei Han, Micheline Kamber, and Jian Pei's "Data Mining: Concepts and Techniques"
6. Marc Peter Deisenroth, A. Aldo Faisal & Cheng Soon Ong, “Mathematics for Machine Learning”, Cambridge university press.
7. https://onlinecourses.nptel.ac.in/noc19_cs47/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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
CEPCC503	Computer Network	20	20	60	1	2	100	

Prerequisite: Computer Organization and Architecture, Programming Fundamentals	
Course Objectives: The course aims to	
1	To introduce concepts and fundamentals of data communication and computer networks.
2	To explore the inter-working of various layers of OSI.
3	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4	To assess the strengths and weaknesses of various routing algorithms.
5	To understand various transport layer and application layer protocols.
Course Outcomes: learner will be able to	
1	Demonstrate the concepts of data communication and compare ISO – OSI model with TCP/IP model.
2	Explore different design issues at the physical layer.
3	Explore different design issues at the data link layer.
4	Design the network using IP addressing and sub netting / supernetting schemes and Analyze various routing algorithms and protocols at network layer.
5	Analyze transport layer protocols and congestion control algorithms.
6	Explore protocols at application layer

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Networking**	05	CO1
	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services Reference models: Layer details of OSI, TCP/IP models. Communication between layers.		
	Self-learning topics: Comparison Between Connection-Oriented and Connectionless Services		
02	**Physical Layer**	03	CO2
	Introduction to Communication Electromagnetic Spectrum Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.		

03	**Data Link Layer** DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, CRC, Checksum), Elementary Data Link protocols, Stop and Wait, Sliding Window (Go Back N, Selective Repeat) Medium Access Control Sublayer Channel Allocation problem, Multiple access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CD) **Self-learning topics:** Comparison of Framing Techniques	09	**CO3**
04	**Network layer** Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classful and classless), Subnetting, Supernetting design problems, IPv4 Protocol, Network Address Translation (NAT), IPv6 Routing algorithms: Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing Protocols - ARP, RARP, ICMP, IGMP Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	12	**CO4**
05	**Transport Layer** The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers TCP Flow control (sliding Window), TCP Congestion Control: Slow Start **Self-Learning Topics:** TCP vs UDP – Comparative Study	07	**CO5**
06	**Application Layer** DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP **Self-Learning Topics:** Hands-on with FTP Commands and File Transfer	06	**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. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet,6th edition, Addison Wesley

References

1 S. Keshav, An Engineering Approach to Computer Networking, Pearson

2 Natalia Olifer & Victor Olifer,Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.

3 Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Second Edition, The Morgan Kaufmann Series in Networking

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

C. 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
CEPEC5011	Natural Language Processing	20	20	60	1	2	100	

Prerequisite: Fundamentals of Python programming, data structures, and probability & statistics.	
Course Objectives: The course aims to	
1	To introduce the core concepts and applications of Natural Language Processing.
2	To explain the structure of language: morphology, syntax, semantics, and pragmatics.
3	To apply statistical and rule-based language modeling techniques.
4	To implement parsing, tagging, and ambiguity resolution methods.
5	To use machine learning for NLP tasks such as text classification and sentiment analysis.
6	To develop NLP applications using Python and libraries like NLTK and spaCy.
Course Outcomes: Learners will be able to	
1	Explain key concepts, challenges, and applications of NLP.
2	Analyse linguistic structures using morphological and statistical methods.
3	Apply grammar formalisms and probabilistic models for parsing.
4	Perform semantic analysis and word sense disambiguation.
5	Build and evaluate statistical language models.
6	Develop NLP applications such as sentiment analysis and machine translation.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to NLP** Introduction to NLP Definition, origin, and evolution of NLP; stages of NLP: morphological, syntactic, semantic, pragmatic, and discourse; key challenges and applications. Linguistic Basics and Text Processing Linguistic levels: morphology, syntax, semantics, pragmatics; text processing steps: tokenization, stop-word removal, stemming, lemmatization, POS tagging; overview of tools like NLTK and spaCy.	6	**CO1**

	Self-Learning Topics: Evolution of NLP approaches: rule-based, statistical, and neural methods.		
02	**Word Level Analysis and Morphology** Word Structure and Morphological Analysis Word formation, lexemes, morphemes, inflectional and derivational morphology; morphological parsing using Finite State Transducers (FST). Word Formation and Spelling Correction Regular expressions and finite-state automata for word recognition; spelling error detection and correction using Minimum Edit Distance. **Self-learning topics:** Study finite-state morphology and its role in word analysis.	7	**CO2**
03	**Language Modeling** Introduction to Statistical Language Models Concept of language modeling; probability of word sequences; N-gram models: unigram, bigram, trigram; estimation of N-gram probabilities. Model Evaluation and Smoothing Techniques Evaluation metrics: perplexity and cross-entropy; need for smoothing; Laplace, Good-Turing, and Interpolation methods; handling unseen words. **Self-learning topics:** Study the challenges and limitations of N-gram models in language modeling.	7	**CO3**
04	**Syntax and Parsing Techniques** Grammar and Syntactic Structure Concept of syntax; phrase structure grammar and dependency grammar; Context-Free Grammar (CFG): rules, derivations, and parse trees. Parsing Algorithms and Ambiguity Resolution Parsing approaches: top-down and bottom-up parsing, shift-reduce and CYK algorithms; Probabilistic Context-Free Grammar (PCFG); syntactic ambiguity and disambiguation strategies. **Self-learning topics:** Study treebanks and their role in training and evaluating parsers.	7	**CO4**
05	**Semantics and Pragmatics** Semantic Analysis and Meaning Representation**:** Introduction to semantics; approaches to meaning representation; lexical semantics: synonymy, hyponymy, polysemy; compositional semantics; semantic roles and relations. Word Sense Disambiguation and Pragmatic Analysis**:** Word Sense Disambiguation (WSD) techniques: knowledge-based, supervised, and unsupervised methods; pragmatics: reference, presupposition, and discourse coherence. **Self-learning topics:** Study the role of lexical databases such as WordNet in semantic	7	**CO5**

	interpretation.		
06	**NLP Applications** Core NLP Applications**:** Overview of NLP applications: text classification, sentiment analysis, question answering, and information retrieval; document representation and feature extraction (TF-IDF, Bag-of-Words). Advanced Applications and Trends: Machine translation, text summarization, and dialogue systems; introduction to neural NLP: RNN, LSTM, and Transformer (overview only). **Self-learning topics:** Explore ethical issues, bias, and evaluation challenges in modern NLP applications.	8	**CO6**

Text Books:

1. **Daniel Jurafsky & James H. Martin**, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, 3rd Edition Draft, Pearson, 2024.
2. **Christopher D. Manning & Hinrich Schütze**, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
3. **Steven Bird, Ewan Klein, and Edward Loper**, Natural Language Processing with Python, O'Reilly Media, 2009.

References:

1. **Daniel M. Bikel & Imed Zitouni**, Multilingual Natural Language Processing Applications: From Theory to Practice, Pearson, 2013.
2. **Tanveer Siddiqui & U.S. Tiwary**, Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
3. **Nitin Indurkhya & Fred J. Damerau**, Handbook of Natural Language Processing, 2nd Edition, CRC Press, 2010.
4. **Alexander Clark, Chris Fox, & Shalom Lappin**, The Handbook of Computational Linguistics and Natural Language Processing, Wiley, 2012.
5. 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 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
CEPEC5012	Soft Computing	20	20	60	1	2	100	

Prerequisite: A strong mathematical background and Proficiency with algorithms	
Course Objectives: The course aims to	
1	Introduce students to soft computing concepts and techniques.
2	Develop a solid foundation in the theoretical concepts of fuzzy logic, neural networks, and evolutionary algorithms
3	Enable the understanding of the integration of soft computing with other fields.
4	Enhance students' abilities to apply soft computing methods to solve complex real-world problems.
Course Outcomes: Learners will be able to	
1	Explain the components and applications of soft computing.
2	Conceptualize fuzzy logic and its implementation for real world applications.
3	Apply genetic algorithms for real-time search, optimization, and design problems.
4	Analyze various neural network architectures.
5	Apply Hybrid approach for expert system design.
6	Familiarize with nature inspired algorithms, and their applications in optimization and search problems.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Soft Computing** Introduction of soft computing, soft computing vs. hard computing, Characteristics of Soft computing, various types of soft computing techniques, applications of soft computing.	06	**CO1**
02	**Fuzzy Logic** Introduction to Fuzzy logic, Fuzzy sets and membership functions., Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences., Defuzzification techniques, Fuzzy logic controller design, Some	08	**CO2**

	applications of Fuzzy logic.		
03	**Genetic Algorithms** Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures., GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using GAs **Self-learning topics:** Applications of Genetic Algorithms in parameter optimization and machine learning.	08	**CO3**
04	**NEURAL NETWORKS** Introduction – Fundamental concept– Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron. Neural Network Architecture: Perceptron, Single layer Feed Forward ANN, Multilayer Feed Forward ANN, Activation functions, Supervised Learning: Delta learning rule, Back Propagation algorithm. Un-Supervised Learning algorithm: Self Organizing Maps	09	**CO4**
05	**Hybrid Systems** Types of Hybridizations, Neuro-fuzzy systems, Neuro-genetic Systems, Fuzzy genetic systems, Applications of hybrid systems. **Self-learning topics:** Applications of Hybrid Soft Computing techniques	05	**CO5**
06	**Swarm Intelligence optimization** Introduction to Swarm Intelligence, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) **Self-learning topics:** Real-world case studies combining fuzzy logic, neural networks, and evolutionary algorithms	06	**CO6**

Text Books:

1. Samir Roy and Chakraborty, —Introduction to soft computing‖, Pearson Edition.
2. S.N. Sivanandam, S.N. Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
3. S. Rajasekaran and G.A. Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning. 5. N.P. Padhy, —Artificial Intelligence and Intelligent Systems, Oxford University Press
4.Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.

References:

1. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
2. Zimmermann H.S "Fuzzy Set Theory and its Applications"Kluwer Academic Publishers.
3. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.
4. Eiben and Smith, “Introduction to Evolutionary Computation", Springer, ISBN-10: 3642072852
5. online nptel link https://onlinecourses.nptel.ac.in/noc25_ma54/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
CEPEC5013	Image Generation and Rendering	20	20	60	1	2	100	

Prerequisite: Knowledge of C Programming and Basic Mathematics	
Course Objectives: The course aims to	
1	Equip students with fundamental knowledge and technical competence in digital image generation and rendering.
2	Emphasize the implementation of algorithms for image generation, rasterization, and geometric transformations.
3	Prepare students for advanced applications in rendering systems and image-based technologies.
Course Outcomes: Learners will be able to	
1	Describe the basic concepts of image generation and rendering systems.
2	Demonstrate algorithms for generating graphical primitives such as lines, circles, and polygons.
3	Apply two-dimensional geometric transformations to digital objects.
4	Implement viewing and clipping techniques in rendering.
5	Analyze three-dimensional transformations, projections, and image generation techniques.
6	Evaluate visible surface detection methods and basic animation techniques

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Image Generation and Graphics Systems** Introduction to image generation in the context of rendering systems, Overview of coordinate systems, Raster scan and random scan displays, Architecture of raster-based image, generation systems (with display processor), Architecture of random scan systems, Introduction to scan conversion, rasterization, and rendering, Representative applications of image generation	4	**CO1**
02	**Output Primitives and Rasterization Algorithms** Scan conversion of point, line and circle. Line drawing algorithms: DDA algorithm and Bresenham's algorithm. Circle drawing algorithm: Midpoint circle algorithm (mathematical derivation expected). Aliasing and Anti-aliasing techniques: Pre-filtering, Post-filtering, Super sampling and Pixel phasing. Filled Area Primitives: Inside-outside tests, Boundary fill algorithm, Flood fill algorithm and Scan-line polygon fill algorithm. **Self-learning Topics:** Midpoint Ellipse Drawing Algorithm	9	**CO2**

03	**Two Dimensional Geometric Transformations** Role of geometric transformations in image generation and rendering, Basic transformations: Translation, Scaling, Rotation, Matrix representation, Homogeneous Coordinates Composite transformation, Other transformations: Reflection and Shear	6	**CO3**
04	**Two-Dimensional Viewing and Clipping** Introduction to viewing pipeline as a stage in rendering, Viewing transformation pipeline and Window-to-Viewport coordinate transformation, Clipping operations: Point clipping algorithm, Line clipping algorithms: Cohen-Sutherland, Liang-Barsky, Polygon Clipping Algorithms: Sutherland-Hodgman, Weiler -Atherton.	8	**CO4**
05	**3D Transformations and Rendering** Introduction to 3D graphics in image generation, 3D Transformations: Translation, Rotation, Scaling and Reflection, Projections: Parallel, Perspective. (Matrix Representation) Bezier Curve, Basic concepts of Image-Based Rendering: Alternative approach to image generation using real images instead of geometric modelling, comparison with traditional rendering techniques, and applications in visualization and virtual environments. **Self-learning Topics:** Fractal Geometry: Fractal Dimension, Koch Curve.	8	**CO5**
06	**Visible Surface Detection and Animation Techniques** Introduction and need for visible surface detection in rendering, Classification of visible surface detection algorithms: Object-Space: back-face, Detection Method and Image-Space: Z-Buffer Method, Painter's Algorithm. Role of visible surface detection in rendering pipeline, Introduction to animation in image generation, Principles of Animation, Key Framing Techniques, Basic concepts of character and motion animation, introduction to Motion Capture.	7	**CO6**

Textbooks:	
1	Hearn & Baker, "Computer Graphics c Version", 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2ndEdition, Pearson Publication
3	Samit Bhattacharya," Computer Graphics", Oxford Publication
4	https://onlinecourses.nptel.ac.in/noc20_cs90/preview
References:	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum's Outlines McGraw-Hill Education
3	Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.

Assessment: -

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/Oral examination/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

C. 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
CEPEC5014	Big Data Analytics	20	20	60	1	2	100	

Prerequisite: Database Management System, Data Mining and Programming Fundamentals	
Course Objectives: The course aims to	
1	To provide an overview of the big data platforms, its use cases and Hadoop ecosystem.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL
3	To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex real-world problems for decision support.
Course Outcomes: Learners will be able to	
1	Understand the building blocks of Big Data Analytics.
2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems
3	Understand different NoSQL systems and how it handles big data
4	Apply advanced techniques for emerging applications like stream analytics
5	Achieve adequate perspectives of big data analytics in various applications like recommender s systems, Social Media Applications
6	Design and implement algorithms to analyse Big data in Web Graph.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Big Data** Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	04	**CO1**
02	**Hadoop HDFS and MapReduce** Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks,	07	**CO2**

	Combiners, Details of MapReduce Execution, Coping with Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce Hadoop Limitations		
03	**NoSQL** Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study. NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems. **Self-learning topics:** Apache Storm, Using Apache Storm for Real-time Data Analysis	07	**CO3**
04	**Mining Data Streams** The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing, Sampling Data techniques in a Stream, Filtering Streams: Bloom Filter with Analysis, Counting Distinct Elements in a Stream, Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	08	**CO4**
05	**Real-Time Big Data Models** A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering. Case Study: Product Recommendation. Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph **Self-learning topics:** Explainable AI (XAI) for Big Data Models	08	**CO5**
06	**Link Analysis** History of search engines and spam, Page Rank, PageRank Computation, Structure of the Web, Efficient computation of PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Link spam, spam Farm, Link Spam Combating Techniques, Hubs and authorities, Hyperlink-Induced Topic Search Algorithm **Self-learning topics**: Graph Generative Adversarial Networks (GraphGAN) for Link Prediction and Authority Learning	08	**CO6**

Text Books:

1. Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets‖, Cambridge University Press
2. Alex Holmes —Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly —Making Sense of NoSQL– A guide for managers and the rest of us, Manning Press.
4. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications,

References

5. Bill Franks , —Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics‖, Wiley
6. Chuck Lam, —Hadoop in Action‖, Dreamtech Press
7. https://nptel.ac.in/courses/106104189

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2*+2 Hrs
		Internal Assessment		Oral	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
CEVSEC501	**Computational Lab**	-	50	25	-	-	75	

* e- learning

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

Learners should select any course from MKCL/ NPTEL/ SWAYAM/ MOOCS/ Infosys Springboard/ Edunet/ Coursera, etc.[#]
Few suggested certification courses are: SQL Mastery, IoT, Robotics, Cyber Security Essentials, Network Security, 3D Modelling, Data Analysis and Visualization Techniques, AI Tools, Advanced Tools and Techniques, Any high-level programming language, etc. [#] Any other relevant course in discussion with the concerned faculty. The course duration should be 28 to 30 Hours.

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, Learner must submit a file containing their Lab performances, Online Certifications/ Course Project report.

Oral Exam (25 Marks)

An Oral exam will be held based on the 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
CEPCL501	**Machine Learning Lab**	-	25	25	-	-	50	

Prerequisite: Python	
Course Objectives: The course aims to	
1	To familiarize students with data preprocessing, visualization, and basic statistical analysis techniques essential for machine learning.
2	To develop proficiency in implementing supervised and unsupervised learning algorithms
3	To enable students to explore Neural networks
4	To provide hands-on experience in applying Machine Learning solution to a real-world problem
Course Outcomes: Learners will be able to	
1	Apply data preprocessing and visualization techniques
2	Implement and evaluate supervised learning algorithms
3	Build regression models and ensemble techniques
4	Apply unsupervised learning techniques
5	Implement dimensionality reduction and neural network models
6	Apply machine learning techniques to solve real-world problems and demonstrate teamwork, critical thinking, and problem-solving abilities.

Suggested List of Experiments

Sr. No.	Final list of experiments should cover all COs and consist of 10 experiments including mini project	CO Mapping
01	Implement basic data preprocessing techniques like handling missing values, encoding categorical data, feature scaling, visualize datasets, split datasets into training and testing sets and compute training and generalization errors.	CO1
02	Implement and evaluate using confusion matrix, accuracy, precision, recall, F1-score, and ROC curve. • Naïve Bayes Classifier for a given dataset (e.g., spam detection, iris classification). • Decision Tree Classifier and visualize the tree structure; compute information gain, entropy, and Gini Index. • Apply Support Vector Machine (SVM) for linear and nonlinear classification using kernel functions.	CO2

03	Implement and evaluate • Linear Regression • Logistic Regression for binary classification tasks and plot the decision boundary. • Implement Ensemble Techniques – Bagging, Random Forest, AdaBoost, and Gradient Boost; compare their performance. • Perform K-fold Cross Validation and analyze model accuracy and variance.	CO3
04	Implement and evaluate • K-Means and K-Medoids Clustering algorithms and visualize clusters for given datasets. • Hierarchical Clustering algorithm and represent results with a dendrogram. • DBSCAN algorithm • Apriori or FP-Growth algorithms to perform Association Rule Mining.	CO4
05	Reduce dimensionality of a dataset and visualize reduced features • Principal Component Analysis • Linear Discriminant Analysis	CO5
06	• Implement a Single-Layer Perceptron for binary classification. • Build a Multi-Layer Neural Network using backpropagation	CO5
07	Develop a simple end-to-end ML application to integrate concepts learned throughout the course and develop an end-to-end Machine Learning solution to a real-world problem using appropriate datasets, algorithms, and evaluation metrics.	CO6

Continuous Internal Evaluation (25 Marks)

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

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on 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
CEPCL502	Computer Network Lab	-	25	25	-	-	50	

Prerequisite: Programming fundamentals	
Course Objectives: The course aims to	
1	To practically explore OSI layers and understand the usage of simulation tools
2	To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3	To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols
Course Outcomes: Learners will be able to	
1	Design and setup networking environment in Linux.
2	Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols
3	Implement programs using core programming APIs for understanding networking concepts.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of RJ45 and CAT6 Cabling and connection using crimping tool.	CO1
02	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)	CO1
03	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.	CO1
04	Perform network discovery using discovery tools (eg. Nmap, mrtg)	CO1
05	Use Wire shark 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	CO2
06	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.	CO2
07	Study and Installation of Network Simulator (NS3)	CO3

08	a. Set up multiple IP addresses on a single LAN. b. Using nestat 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 Iptables in Linux.	CO3
09	Design VPN and Configure RIP/OSPF using Packet tracer.	CO3
10	Socket programming using TCP or UDP	CO3
11	Perform File Transfer and Access using FTP	CO3
12	Perform Remote login using Telnet server	O3

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
CEPEL5011	Natural Language Processing Lab	-	25	25	-	-	50	

Prerequisite: Fundamentals of Python programming, data structures, and probability & statistics.	
Course Objectives: The course aims to	
1	To implement key NLP preprocessing techniques.
2	To understand and apply language modeling and morphological analysis.
3	To design and test POS tagging and parsing algorithms.
4	To apply NLP models for classification, translation, and sentiment analysis.
5	To develop and evaluate small NLP applications using Python and NLTK/spaCy.
Course Outcomes: Learners will be able to	
1	Apply basic text preprocessing techniques for language data.
2	Implement statistical language models.
3	Perform POS tagging and syntactic parsing using grammar formalisms.
4	Analyze semantic relationships and perform word sense disambiguation.
5	Develop end-to-end NLP applications such as sentiment analysis or machine translation.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Perform text preprocessing: tokenization, script validation, and stop-word removal using Python.	CO1
02	Implement stemming and lemmatization techniques; compare and analyze results.	CO1
03	Implement the Minimum Edit Distance algorithm for spelling correction and evaluate on sample text.	CO1, CO2
04	Develop and analyze N-gram language models (unigram, bigram, trigram); compute sequence probabilities and evaluate perplexity.	CO2
05	Perform Part-of-Speech (POS) tagging using rule-based and probabilistic approaches; analyze tagging accuracy for a given corpus.	CO3

06	Implement syntactic parsing using a small Context-Free Grammar (CFG) with top-down or bottom-up parsing.	CO2
07	Perform Named Entity Recognition (NER) and chunking to extract noun phrases and named entities using NLTK/spaCy.	CO4
08	Implement Word Sense Disambiguation using the Lesk algorithm; explore semantic relations (synonyms, antonyms, hypernyms) using WordNet.	CO4
09	Build and evaluate a text classification model using Naïve Bayes or SVM for sentiment analysis on a sample dataset.	CO2, CO5
10	Develop a mini-project in groups (3–4 students) based on one NLP application: Chatbot, Machine Translation, Summarization, or Question Answering.	CO5

Continuous Internal Evaluation (25 Marks)

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

Oral & 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
CEPEL5012	**Soft Computing Lab**	-	25	25	-	-	50	

Prerequisite: Python, and Proficiency with algorithms	
Course Objectives: The course aims to	
1	Introduce students to soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world and engineering problems.
2	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
3	Apply the supervised/unsupervised learning algorithm.
4	Evaluate and compare solutions by various soft computing approaches for a given problem
Course Outcomes: Learners will be able to	
1	Analyze and integrate various soft computing techniques in order to solve problems effectively and efficiently.
2	Students will be able to understand the soft computing techniques like neural networks and fuzzy logic and their roles in building intelligent systems. .
3	Student will be able to implement genetic algorithms for different modelling
4	Apply soft computing techniques to solve engineering or real-life problems

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relations by Cartesian product of any two fuzzy sets and perform maxmin composition on any two fuzzy relations.	CO1, CO2
02	To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem.	CO2
03	Generate AND/NOT function using McCulloch-Pitts neural network	CO2
04	Design a simple linear neural network model and calculate the output of neural net using both binary and bipolar sigmoidal function	CO2
05	Implement a Single-Layer Perceptron for binary classification using Python.	CO2
06	Write a program to implement artificial neural networks with back propagation.	CO2
07	Implementation of Simple genetic algorithm and create two classes: City and Fitness using Genetic algorithm	CO3

08	Implement, Ant Colony Optimization (ACO) Technique/Particle swarm optimization technique	CO4
09	Case study on Hybrid Systems.	CO4

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
CEPEL5013	Image Generation and Rendering Lab	-	25	25	-	-	50	

Prerequisite: C Programming Language	
Course Objectives:	
1	Understand the need for developing digital image generation and rendering applications
2	Learn algorithmic development of image primitives such as line, circle, and polygon
3	Learn the representation and transformation of digital images and visual objects
Course Outcomes: Learners will be able to	
1	Implement algorithms for image primitives such as line and circle generation
2	Develop filled-area algorithms for polygon-based images
3	Apply transformation techniques to digital objects
4	Apply projection and clipping techniques for image viewing and visibility processing
5	Perform curve and fractal generation methods.
6	Develop a basic graphics application incorporating image generation, rendering effects, or animation

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Implement DDA Line Drawing algorithm	CO1
02	Character Generation: Bit Map method and Stroke Method	CO1
03	Implement Bresenham's Line Drawing algorithm	CO1
04	Implement the Midpoint Circle algorithm.	CO1
05	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.	CO2
06	Implement transformations: Translation, Scaling, Rotation, Reflection, Shear.	CO3
07	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.	CO4
08	Implement polygon clipping algorithm	CO4
09	Perform projection of a 3D object on Projection Plane: Parallel and Perspective.	CO4
10	Implement Bezier Curve for n control points	CO5
11	Implement Fractal generation method	CO5
12	Implement shading effect using color intensity variation	CO6
13	Implement basic rendering of a polygon using scan-line filling with color intensity variation	CO2, CO6
14	Perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc.)	CO6

Continuous Internal Evaluation (25 Marks)

1. Term work should consist of 10 experiments covering all modules.
2. Lab Performance: 10 Marks
3. In-Semester Practical Examination/Quiz/Oral during lab session: 10 Marks
4. 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
CEPEL5014	Big Data Analytics Lab	-	25	25	-	-	50	

Course Objectives: The course aims to	
1	Solve Big Data problems using Map Reduce Technique and apply to various algorithms.
2	Impart knowledge of Map reduce paradigm to solve complex problems Map-Reduce.
3	Introduce to the students several types of big data like social media, web graphs and data streams
4	Enable students to have skills that will help them to solve complex real-world problems in decision support.
Course Outcomes: Learners will be able to	
1	Demonstrate capability to use Big Data Frameworks like Hadoop
2	Program applications using tools like Hive, pig, NO SQL and MongoDB for Big data Applications
3	Design and implement algorithms to analyse Big data like stream data, Web Graphs, Social Media data and construct recommendation systems.
4	Apply the knowledge of Big Data gained to fully develop BDA applications for real life applications.

Suggested List of Experiments

Suggested Experiments: Students are required to complete at least 08 experiments.		
Star (*) marked experiments are compulsory.		
Sr. No.	**List of Experiments**	**CO Mapping**
01(*)	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and delete file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop	CO1
02(*)	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands	CO2
03(*)	Experiment on Hadoop Map-Reduce: -Write a program to implement a word count program using MapReduce.	CO1
04	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc	CO1
05	Create HIVE Database and Descriptive analytics-basic statistics.	CO2

06(*)	Data Stream Algorithms (any one): - Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language	CO3
07	Social Network Analysis using R (for example: Community Detection Algorithm)	CO3
08	Data Visualization using Hive/PIG/R/Tableau/.	CO2
09	Exploratory Data Analysis using Spark/ Pyspark.	CO4
10(*)	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). - Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. - Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) Spatio-Temporal Data Analytics	CO4

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.

Multidisciplinary Minor Course II

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

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

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Databases**	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**		

	Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	10	**CO3**
04	**Relational Algebra and Calculus** Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	10	**CO4**
05	**Constraints, Views and SQL** What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL Tools: MySQL, ORACLE 10G, POSTGRESQL	10	**CO5**
06	**Transaction management and Concurrency control** Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy: Issues, Access Control based on grant and revoke privileges	5	**CO6**
	Total	**42**	

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

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

Suggested List of Experiments

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

Continuous Internal Evaluation (25 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	3 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETMDM501	Digital Communication and 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	06	**CO2**

	Self-Learning Topics: Study how source coding reduces data size in practical file compression and transmission.		
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 Topics**: M-ary encoding: M-ary FSK and M-ary PSK	12	**CO4**
05	**Fundamentals of Sensor Technology** Introduction to Sensors, Classification, Selection, and Characteristics of Sensors: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy Primary Sensing Elements and Signal Conditioning, Principles, Construction, and Applications of Common Sensors (potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor).	06	**CO5**
06	**Transducer and Microsensor Technologies** Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: capacitor microphone, capacitive pressure sensor, proximity sensor Micro Sensors and Micro Actuators: Principles, Types and examples **Self-Learning Topics:** Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors**.**	08	**CO6**

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						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 and Sensor Technology Lab**	-	25	-	-	-	25	

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

Suggested List of Experiments

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

04	To design and implement Huffman coding for a given discrete source and calculate code efficiency and redundancy.	CO2
05	Linear block code generation and error detection	CO3
06	Cyclic code generation and error detection	CO3
07	Convolutional code generation	CO3
08	Line Codes generation and performance comparison	CO4
09	Generation (and detection) of Binary ASK, Binary PSK, and Binary FSK.	CO4
10	Generation (and detection) of QPSK	CO4
11	Study of Characteristics of a Potentiometer as a Displacement Sensor	CO5
12	Study of LVDT (Linear Variable Differential Transformer) Characteristics	CO5
13	Study of Capacitive Transducer for Displacement or Pressure Measurement	CO5
14	Study and Characterization of a Thermistor (Temperature Sensor)	CO6
15	Study of Photo-resistive Sensor (LDR) characteristics (Light intensity vs resistance)	CO6
16	Demonstration of MEMS-based sensors (e.g., accelerometer, pressure sensor using Arduino or NI-ELVIS)	CO6

Continuous Internal Evaluation (25 Marks)

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

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

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

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

	static and dynamic characteristics. 2.2. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety, etc. Principle and selection of mechano-electrical actuators, i) DC motors, ii) Stepper Motors, iii) Solenoid Actuators, iv) Servo Motors, v) BLDC	07	**CO2**
	Self-Learning Topic: Examples of sensors used in household appliances (fridge, washing machine, AC), Comparison of DC motor vs Stepper motor in simple applications, Selection of an actuator for a small robotic arm		
03	**Data Acquisition, Signal Conditioning & Microcontroller System Theory** 3.1. Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Converter), Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Converter), R-2R circuit and DAC resolution 3.2. Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	07	**CO3**
	Self-Learning Topic: Use of low-pass filter in removing noise from a sensor signal, Applications of band-pass filters		
04	**Design of Pneumatic & Hydraulic Circuits** 4.1. Design of Pneumatic Sequencing Circuits using the Cascade method and the shift register method (up to 2 cylinders) 4.2. Basic Hydraulic Circuits: Meter in, meter out, and bleed off circuits; Intensifier circuits, Regenerative Circuit, Counterbalance valve circuit and sequencing circuits.	08	**CO4**
	Self-Learning Topic: Identification of hydraulic circuits used in industry (press machines, lifting systems), Simple case study of meter-in vs meter-out control in hydraulic actuators, Safety precautions in handling hydraulic and pneumatic systems		
05	**Design of Electro-pneumatic Circuits** 5.1. Electro-pneumatic Circuits Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves, with and without grouping. 5.2. PLC Discrete Control Systems Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.	08	**CO5**
	Self-Learning Topic: Identification of electro-pneumatic components used in industrial machines, Real-life examples of pneumatic systems in automation, Safety rules and precautions when working with pneumatic circuits		
06	**Reliability, communication, and Case studies** 6.1. Reliability, maintainability, safety, and fault diagnosis in mechatronic systems		

	6.2. Communication Protocols (overview only), CAN, UART, SPI, I2C (basics only) 6.3. Case Studies: Automotive ABS, CNC feed drive system, Pick & place robot, Smart manufacturing cell	07	**CO6**

Text Books:

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

References:

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

NPTEL/SWAYAM courses:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

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

Prerequisite: Basic knowledge of electrical and mechanical systems, control theory, and microcontroller programming.	
Course Objectives: The course aims to	
1	Understand fundamentals of mechatronic systems, sensors, and actuators.
2	Interface and control electrical and mechanical devices using microcontrollers
3	Identify and analyze dynamic characteristics of actuators.
4	Apply automated controls using pneumatic and pneumatic. systems.
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.	**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)

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						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: Basic Science, Basic Electrical and Electronics.	
Course Objectives: The course aims to	
1	Make students to understand basics of sensors
2	Make students to understand various type of sensors
3	Make students understand the advance sensors
4	Make students to understand the application of various sensors
Course Outcomes: Learners will be able to	
1	Explain the principles of sensors and transducers
2	Describe various thermal sensors
3	Understand radiation sensors, LDR and other photo devices.
4	Explain the concept of smart sensors
5	Explain the recent development in sensors technology
6	Explain the application of sensors in home, automobile and aerospace etc.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** What are sensors and transducers, principles, classifications, parameters: statics and dynamics characteristics, environmental parameters, electrical characterization, mechanical and thermal characterization, optical characterization. **Self-Learning Topic: Chemical and biological characterization**	7	**CO1**
02	**Thermal Sensors** Introduction, Gas thermometric sensors, thermal expansion type thermometric sensors, acoustic temp. sensor, dielectric constant and refractive index thermo sensor, helium low temp. thermometer, nuclear thermometer, magnetic thermometer, resistance change type thermometric sensor, metal resistance sensors and thermistor**.**	8	**CO2**

	Self-Learning Topic: Resistive potentiometer, strain gauge, quartz crystal thermoelectric sensor.		
03	**Radiation sensor** Introduction, basic characteristic, type of photosensistor/photodetector, the photoemissive cell and photomultiplier, photoconductive cell, LDR, photocurrent, noise, photovoltaic and photojunction cell, photosensitivity cell, photo resistor, Photo FET and other device.	8	**CO3**
04	**Smart Sensors** Introduction, primary sensor, excitation, amplification, filter, converter, compensation, nonlinearity, noise and interference, response time, drift, cross sensitivity, information and coding process, data communication, standard and smart sensors interface, the automation	8	**CO4**
05	**Recent Trend in sensor technology** Introduction, film sensors, thick film and thin film sensors, semiconductor IC technology standard method, microelectromechanical system(MEMS), micro machining, some application example. **Self-Learning Topic: Nano sensor**	8	**CO5**
06	**Sensors-Their Applications** Introduction, automotive sensors, flow rate, pressure, temp, oxygen, torque, position sensors, home appliance sensors, aerospace sensors, static pressure sensor, temp sensing, fluid velocity sensor, sensing airflow direction, measuring air speed in aircraft, monitoring strain, force , thrust and acceleration. **Self-Learning Topic: sensors for environmental monitoring**	6	**CO6**

Text Books:

1. D. Patranabis: Sensor and Transducers; second Edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.
3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

References:

1. A. K. Sawhney, "a course in electrical and electronics measurement and instrumentation" DhanpatRai & Co. 3rd Edition.
2. Nakra B. Choudhary K.k, "instrumentation, Measurement and analysis, second Edition, Tata McGraw-Hill Publication Ltd.
3. https://onlinecourses.nptel.ac.in/noc21_ee32/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						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hours
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ITMDML501	Sensors Actuators and Transducers Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Make students to understand basics of sensors
2	Make students to understand various type of sensors
3	Make students understand the advance sensors
4	Make students to understand the application of various sensors
Course Outcomes: Learners will be able to	
1	Work with electrotechnical, potentiometric sensors
2	Experiments with thermistor, thermocouple etc
3	Use radiation sensors, LDR and other photo devices
4	Explain the concept of smart sensors
5	Explain the recent development in sensors technology
6	Explain the application of sensors in home, automobile and aerospace etc.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
1	Potentiometric sensor	CO1
2	Resistive sensor	CO1
3	Thermister	CO2
4	Thremocouple	CO2
5	Photo diode, photo transistor	CO3
6	LDR	CO3
7	Gas sensor	CO4
8	Understanding modern sensors through simulation	CO5

9	Experiments on automobile sensors	CO5
10	Experiments on optical sensors	CO6
11	Experiment on flow sensor	CO6

1. Minimum 8 experiments are compulsory for the term work.
2. Min 3 Assignment on self-learning topics

Continuous Internal Evaluation (25 Marks):

1. Lab Performance: 10 Marks
2. Mid Semester Oral & Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks

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

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

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

	Resources of Wind, Classification of Wind Mills, Wind Energy Conversion System (WECS), Performance Characteristics of Wind Mill, Application of wind energy & Site Selection.	07	**CO5**
06	**Other Renewable Energy Sources.**	06	**CO6**
	Mini & Micro Hydro Electric Plants, Application & Site Selection. Hybrid Energy, Economic Environmental & Regulatory Aspects of Renewable Sources.		
	Self-Learning Topic: Hydrology		

Text Books:

8. "Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409-073-7
9. "Solar Energy: Principles of Thermal Collection and Storage", SP Sukhatme and J K Nayak, 4th Edition, Tata McGraw Hill Publishing Co. Ltd.
10. "Renewable Energy Sources", J W Twidell& Anthony D. Weir, 3rd Edition 2015, ELBSPub, ISBN: 978-1-315-76641-6
11. Power Plant Engineering by Prof, V M Domkundwar
12. 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)

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

End Semester Examination (60 Marks)

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

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

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)

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

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

Prerequisite: 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	07	**CO2**

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

Text Books

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

References:

1. T. J. E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, Clarendon Press.
2. R. Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice Hall.
3. D. P. Kothari and I. J. Nagrath, *Electric Machines*, Tata McGraw Hill.
4. G. K. Dubey, *Fundamentals of Electrical Drives,* Narosa Publications
5. Yezdani, and Reza Iravani, Voltage Source Converters in Power Systems: Modeling, Control and Applications, John Wiley Publications, 2010.
6. Dorin Neacsu, Power Switching Converters: Medium and High Power, CRC Press, 2006.
7. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012.
8. IEEE standards —IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems IEEE standards 2003.
9. IEEE standards —IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System.
10. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS Microgrid Concept' 2002.
11. NPTEL Course: DC Microgrid and Control System, Prof. Avik Bhattacharya, IIT Roorkee.

Website Reference / Video Courses:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

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

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

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of Smart Grid components.	CO5
02	Simulation on Modelling of PV system using MATLAB.	CO6
03	Simulation on Modelling of DFIG based wind power system.	CO6
04	Simulation of Grid connected PV MPPT single stage. CO1	CO6
05	To measure and analyze the power quality parameters with and without compensation. (voltage, THD, pf and current)	CO5
06	Simulation/Emulation of DC Microgrid with steady state/transient performance analysis	CO5
07	Simulation/ Emulation of AC Microgrid with steady state/transient performance analysis.	CO5
08	Study of solar PV characteristics	CO6
09	Study of constructional features and working principle of different special motors (Stepper, SRM, BLDC, PMSM, LIM).	CO1 to CO4
10	Speed control of a Stepper Motor using Arduino or Microcontroller Interface.	CO1
11	Determination of Step Angle and Resolution of Stepper Motor.	CO1

12	Characteristics of Switched Reluctance Motor (SRM).	CO2
13	Speed control of SRM using a power converter.	CO2
14	Study of Permanent Magnet Synchronous Motor (PMSM).	CO4
15	Experimental setup of PMSM drive using inverter and controller.	CO4
16	Study of BLDC motor and its characteristics.	CO3
17	Integration of special motor with sensor and control module for application (e.g., robotic arm / conveyor).	CO3

Virtual Lab Website Reference:

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

Continuous Internal Evaluation (25 Marks)

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

Department of Computer Engineering

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
CEPCC601	**Software Engineering**	20	20	60	1	2	100	

Prerequisite: Object-Oriented Programming with Java or Python	
Course Objectives: The course aims to	
1	To understand key concepts, principles and models of software engineering.
2	To analyze and model software requirements using structured and object-oriented methods.
3	To apply estimation, planning, and scheduling techniques for project management.
4	To design software architecture and user interfaces using standard principles.
5	To apply testing, quality assurance, and configuration management with Agile and DevOps practices.
Course Outcomes: Learners will be able to	
1	Identify software requirements and select suitable process models.
2	Analyze requirements and develop structured models and SRS.
3	Estimate size, effort, and cost, and manage project planning and tracking.
4	Design systems using UML and standard design principles.
5	Apply testing and quality assurance methods for software.
6	Manage configuration and maintenance, adopting DevOps, AI, and cloud-native practices.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Software Engineering & Process Models** Software Engineering Definition (IEEE), characteristics of software, software applications and domains Software process framework and Capability Maturity Model (CMM) Overview of prescriptive (Waterfall, Incremental, Spiral) and Agile models (Scrum, XP); introduction to DevOps and Continuous Integration/ Continuous Deployment (CI/CD) **Self-learning topics:** Comparison of prescriptive vs. adaptive process models Overview of CMMI levels and software process improvement initiatives	7	**CO1**
02	**Software Requirements Analysis & Modeling**		

	Types of requirements, requirement elicitation techniques Requirement management and validation, Requirement Traceability Matrix (RTM). Requirement modeling using Use Case Diagrams, Data Flow Diagrams (DFD), and Entity-Relationship (ER) Diagrams.	7	**CO2**
	Self-learning topics: Case study on requirement elicitation using Agile approaches. IEEE standards for Software Requirements Specification (IEEE 830).		
03	**Software Estimation, Planning and Control**	7	**CO3**
	Software size, effort, and cost estimation – LOC, Function Point Analysis, COCOMO models. Project planning and scheduling – WBS, Gantt and PERT charts. Project tracking and control– progress monitoring, risk management, Agile estimation (story points, velocity).		
	Self-learning topics: Case study on Function Point Analysis (FPA). Use of open-source project management tools (ProjectLibre, Gantt Project).		
04	**Software Design**	7	**CO4**
	Design principles – modularity, cohesion, coupling, abstraction, reuse. Architectural styles – layered, client-server; UML diagrams – Class and Sequence. Design patterns – Singleton, Factory; basics of UI design and usability.		
	Self-learning topics: Exploring open-source UML tools (StarUML, PlantUML). Modern UI/UX design principles and usability heuristics.		
05	**Software Testing and Quality Assurance**	7	**CO5**
	Testing fundamentals and levels – unit, integration, system, and acceptance testing. Testing techniques – black-box and white-box; overview of automation tools (Selenium, JUnit, PyTest). Software quality assurance – test metrics, defect tracking, and continuous testing overview.		
	Self-learning topics: Automated testing using open-source frameworks. Software quality models (ISO/IEC 25010).		
06	**Configuration Management, Maintenance and Emerging Trends**	7	**CO6**
	Software Configuration Management (SCM) – version control, branching, merging, and release management. Software maintenance types, basics of refactoring.		

	Emerging trends – DevSecOps, AI-driven SE, cloud-native development, gree engineering.		
	Self-learning topics: Version control using Git and GitHub. Overview of DevSecOps and ethical software practices.		

Text Books:

1. Software Engineering: A Practitioner's Approach – Roger S. Pressman & Bruce R. Maxim, 9th Edition, McGraw-Hill Education, 2020.
2. Software Software Engineering – Ian Sommerville, 9th Edition, Pearson Education, 2010.

References:

1. Engineering Software Products: An Introduction to Modern Software Engineering – Ian Sommerville, Pearson, 1st Global Edition, 2021.
2. Software Engineering: Theory and Practice – Shari Lawrence Pfleeger & Joanne M. Atlee, Pearson, 4th Edition, 2010.
3. Design Patterns: Elements of Reusable Object-Oriented Software – Erich Gamma et al., Addison-Wesley, 1994.
4. https://nptel.ac.in/courses/106105182

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
CEPCC602	System Software & Compiler Design	20	20	60	1	2	100	

Prerequisite: Theory of Computation, Operating system, Computer Organization and Architecture, Microprocessor fundamentals, Data structures	
Course Objectives: The course aims to	
1	To understand the fundamental concepts, structure, and functionalities of system software such as assemblers, loaders, linkers, and macro processors.
2	To learn the various phases of compiler design — lexical, syntax, and semantic analysis — and their role in program translation.
3	To apply techniques of intermediate code generation, code optimization, and code generation for efficient program execution.
Course Outcomes: Learners will be able to	
1	Explain the role and goals of system software, differentiating between system programs and application programs.
2	Analyze the structure and design of assemblers and macro processors, including their data structures and algorithms.
3	Describe the functions and types of loaders and linkers, and illustrate various loading and linking techniques.
4	Apply lexical and syntax analysis techniques for compiler design using finite automata and context-free grammars.
5	Demonstrate understanding of semantic analysis and syntax-directed translation schemes used in compilers.
6	Develop intermediate code, perform basic code optimization, and generate target code using appropriate techniques.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to System Software** Concept of System Software, Goals of system software, system design and system programming, System program vs Application Program.	02	CO1
02	**Assemblers and Macros** Assemblers - Elements of Assembly Language programming, pass structure of assembler, Forward Reference Problem. Design of Two pass Assembler, data structures used. Macros - Introduction, Macro definition and call, Simple, Parameterized	11	CO2

	macro, positional parameters, keyword parameters. Design of two pass macro processor, data structures used.		
03	**Loaders and Linkers**	05	**CO3**
	Introduction, functions of loaders, Types of Loaders, Compile and Go Loader, Direct Linking Loader, Dynamic linking and loading.		
04	**Analysis Phase: Lexical and Syntax Analysis**	11	**CO4**
	Introduction to compilers, Phases of compilers Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyzer, data structures used. Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down and Bottom up parsers. Study of Bottom up parsers: SR Parser, Operator precedence parser.		
05	**Analysis Phase: Semantic Analysis (Syntax Directed Translation)**	03	**CO5**
	Syntax directed definitions, Evaluation order for SDDs, Applications of Syntax Directed Translation, Syntax Directed Translation Schemes.		
06	**Synthesis Phase**	10	**CO6**
	Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and Quadruples, indirect triple. Code Optimization: Classification of code optimization - Machine Dependent and Machine Independent, Code optimization techniques, Peephole Optimization. Code Generation: Issues in the code generation, Basic blocks and flow graphs.		

Textbooks:	
1	System Software and Compiler Design by Nandini Prasad and Dinakar K. Shivaprasad — Cengage Learning India. ISBN: 978-9387511699.
2	L. L. Beck, System Software: An Introduction to Systems Programming, 3rd ed., New Delhi, India: Pearson Education, 2007.
3	A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: Compilers Principles, Techniques and Tools, Pearson Education, Second Edition.
References:	
1	S. Chattopadhyay, Compiler Design, 2nd ed., New Delhi, India: PHI Learning Pvt. Ltd., 2022.
2	D, M . Dhamdhere, Compiler construction 2e, Macmillan publication, second edition.
3	Lex & Yacc: John R. Levine, Doug Brown, Tony Mason, Lex & Yacc, 2nd ed., O'Reilly Media, 1992. ISBN 978-1565920002.
4	https://nptel.ac.in/courses/106105190
5	https://nptel.ac.in/courses/106106237

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
CEPEC6011	Internet of Things	20	20	60	1	2	100	

Prerequisite: C Programming, Digital Logic and Computer Architecture, Microprocessor, Computer Networks.	
Course Objectives: The course aims to	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Internet of Things (IoT).
2	Illustrate functioning of hardware devices and sensors used for IoT.
3	Analyze network communication aspects and protocols used in IoT.
4	To develop IoT infrastructure for popular applications
Course Outcomes: Learners will be able to	
1	Understand the various concepts, terminologies and architecture of IoT systems.
2	Use sensors and actuators for the design of IoT.
3	Understand and apply various protocols for design of IoT systems
4	To study the basics of IoT Data Analytics and supporting services.
5	Deploy and implement IoT solutions using platforms like Arduino and Raspberry Pi.
6	Understand various applications of IoT

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamentals of IoT** Introduction, Definitions & Characteristics of IoT, Conceptual Framework, Architectural view, Physical & Logical Design of IoT, Enabling Technologies in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.	06	**CO1**
02	**Things in IoT** Sensors/Transducers: Definition, Principles, Classifications, Types, Characteristics and Specifications Actuators -– Definition, Principles, Classifications, Types, Characteristics and Specifications. Smart Object – Definition, Characteristics and Trends Sensor Networks – Architecture of Wireless Sensor Network, Network	08	**CO2**

	Topologies. Enabling IoT Technologies - Radio Frequency Identification Technology, Micro-Electro-Mechanical Systems (MEMS), NFC (Near Field Communication), Bluetooth Low Energy (BLE), LTE-A (LTE Advanced), IEEE 802.15.4–Standardization and Alliances, ZigBee.		
03	**IoT Communication and Protocols** Internet and Web layering, Internet Communication- IP Addresses - MAC Addresses, Generic Web-Based Protocols, IEEE 802 Family of Protocols, Network layer protocols (6LoWPAN). Application layer protocols like MQTT, CoAP, XMPP, and AMQP. **Self-learning topics:** Comparison of IoT Protocols	09	**CO3**
04	**Data Analytics and Cloud Integration:** Data acquisition, processing, and management in IoT, Integration with cloud computing-Cloud Computing Paradigm for Data Collection, Storage and computing, IoT Cloud-Based Services Using the Xively, Nimbit and other platforms.	07	**CO4**
05	**IoT Hardware and Development Platforms:** Design methodology and embedded computing logic, System on Chips, IoT system building blocks, Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board details, Implementing IoT with Raspberry Pi (RPi)- Basic functionality of RPi board, setting up the board by installing OS, first boot and basic configuration of Rpi, Basic Linux Commands, Accessing RPi remotely using networking tools, RPi GPIO pins. **Self-learning topics:** students should independently explore the setup and configuration of a Raspberry Pi board as an IoT device. OS installation, basic configuration, Linux commands, remote access, and GPIO interfacing.	07	**CO5**
06	**IoT Applications** Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.	05	**CO6**

Text Books:

1. Vijay Madisetti and ArshdeepBahga, — “Internet of Things (A Hands-on-Approach)”, 1 st Edition, VPT, 2014.
2. Hakima Chaouchi, — “The Internet of Things Connecting Objects to the Web” ISBN : 978-1-84821-140-7, Wiley Publications
3. Olivier Hersent, David Boswarthick, and Omar Elloumi, — “The Internet of Things: Key Applications and Protocols”, WileyPublications
4. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
5. Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions for Design and Test”, Application Note, 2016

References:

1. Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
3. https://onlinecourses.nptel.ac.in/noc17_cs22/course . **https://onlinecourses.nptel.ac.in/noc19_cs65/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
CEPEC6012	Wireless Network	20	20	60	1	2	100	

Prerequisite: Computer Network	
Course Objectives: The course aims to	
1	Understand the fundamentals and evolution of wireless communication systems
2	Study multiple access techniques and wireless MAC protocols.
3	Explore different types of wireless networks such as MANETs, VANETs, and WSNs.
4	Understand the architecture and technologies behind WLANs, PANs, 4G/5G systems.
5	Analyze wireless network security mechanisms and challenges.
Course Outcomes: Learners will be able to	
1	Understand the principles and applications of wireless communication.
2	Explain MAC protocols, modulation techniques, and multiple access schemes.
3	Compare ad-hoc, sensor, and vehicular wireless networks and access technologies.
4	Analyze architectures of 4G, 5G, WLANs, and PANs.
5	Understand emerging wireless networks and their architecture.
6	Identify and mitigate security threats in wireless communication.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamentals Wireless Communication** Fundamentals of Wireless Communication, Advantages, limitations and applications, Cellular Concepts – Frequency Reuse, Handoff, Roaming Techniques, DSSS and FHSS, Frequency Spectrum: Radio and Infrared; overview of wireless standards (IEEE 802.11, 802.15, 802.16, 4G/5G). **Self-learning topics:** Wireless Communication Fundamentals Networking Basics, Digital Communication Techniques,	07	**CO1**
02	**Evolution of Wireless Technologies and Medium Access Control Protocols** Introduction to Wireless Technologies: GSM, GPRS, CDMA, LTE, UMTS. MAC issues: hidden/exposed terminal problems, CSMA/CA, TDMA/FDMA/CDMA; MAC in WLANs/PANs; IEEE 802.11 MAC (DCF, PCF, HCF); Bluetooth & ZigBee MAC. **Self-learning topics:** Modulation/Demodulation, PSTN, Multiple Access Techniques.	08	**CO2**

03	**Types of Wireless Networks** Ad-hoc networks: MANET & VANET – characteristics, classification, applications, Routing protocols in MANETs (AODV, DSR, OLSR); Vehicular ad hoc networks (VANET) basics. Wireless Sensor Network: Application, advantages and limitations.	08	**CO3**
04	**Wireless LANs, PANs and Access Technologies** WLAN architecture (BSS, ESS); IEEE 802.11 a/b/g/n/ac/ax; WiMAX basics (IEEE 802.16); PANs: Bluetooth, BLE (IEEE 802.15.1), ZigBee (IEEE 802.15.4); WPAN network topologies and protocols.	07	**CO4**
05	**Emerging Wireless Technologies** LTE/LTE-Advanced architecture; 5G NR: key concepts (massive MIMO, mmWave, network slicing); Cognitive radio networks; Satellite & vehicular wireless networks overview. Introduction to WSN, WSN architecture.	07	**CO5**
06	**Wireless Network Security** The need, attacks, security serviced, WEP, Security issues in wireless (eavesdropping, jamming, spoofing); WLAN security: WEP, WPA, WPA2, WPA3; Security in Bluetooth, Authentication and encryption in wireless systems.	05	**CO6**

Text Books:

1. "Wireless Communications and networks", William Stallings, Pearson / Prentice Hall
2. Wireless communication and networking, Vijay Garg
3. Jochen Schiller, *Mobile Communications*, 2nd Ed., Pearson.

References:

1 Andrea Goldsmith, Wireless Communications, Cambridge University Press.
2 Kaveh Pahlavan & Prashant Krishnamurthy, Principles of Wireless Networks: -A Unified Approach, Pearson.
3 N. K. Suryadevara & S. C. Mukhopadhyay (Eds.), Internet of Things and Data Analytics Handbook, Wiley.
4 Wireless Mobile Internet Security, 2nd Edition, Man, Young Rhee, Wiley – IEEE press

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
CEPEC6013	Augmented and Virtual Reality	20	20	60	1	2	100	

Prerequisite: Knowledge of matrices, Programming in C/JAVA Python.	
Course Objectives: The course aims to introduce learners to the	
1	Basic concepts and framework of augmented and virtual reality.
2	Technology for multimodal user interaction and perception in Virtual Reality (VR), particularly the visual, audial and haptic interface and behavior and the technology for managing large scale Augmented Reality (AR) and VR environment.
3	Technology for managing large scale Augmented Reality (AR) and VR environments.
4	Skills that will help them to visualise complex real-world problems for decision support.
Course Outcomes: On completion of the course, the learner will be able to:	
1	Understand the fundamental concepts of Augmented Reality (AR) and Virtual Reality (VR) technologies.
2	Describe and compare the hardware and software technologies used for input and output in AR/VR systems.
3	Analyze methods for representing the virtual world using suitable rendering techniques.
4	Design interactive and immersive AR/VR environments with appropriate navigation and interface to virtual world
5	Apply the spatial mapping in AR and design the user interface for VR.
6	Evaluate AR and VR applications for usability, performance, and user experience.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Augmented Reality (AR) and Virtual Reality (VR):** **Augmented Reality:** Definition and Scope, A Brief History, Displays (Multimodal Displays and Visual Displays), Challenges in AR, Applications of AR **Virtual Reality:** Definition and Scope, Types of VR, Characteristics of VR, Basic VR environments, Limitations of VR environments, Immersion Vs Presence, Key hardware requirements for VR. AR vs VR vs MR **Self-learning topics:** Future trends: Extended Reality (XR) and Mixed Reality (MR) ecosystems, Ethical and psychological aspects of AR/VR, Case studies: AR in education, VR in healthcare	04	CO1
02	**AR and VR Technologies:**		

	Input: User Monitoring, Position Tracking, Body Tracking, Physical input Devices, Speech Recognition and World Monitoring. Output: Visual Displays: Properties of Visual Displays, Monitor-based or Fishtank VR, Projection-based VR, Head-based VR, See-through Head-based Displays, Aural Displays: Types, properties, Haptic Displays**:** Types, properties of Haptic Displays.	08	**CO2**
	Self-learning topics: Depth sensing and SLAM (Simultaneous Localization and Mapping), Emerging input devices: gesture gloves, brain-computer interfaces		
03	**Representing and Rendering the Virtual World:**	08	**CO3**
	Representation of the Virtual World, Visual Rendering Systems: Methods, Types (Geometrically Based and Nongeometric based), Complex Visual Scenes. Computer Graphics System Requirements. Aural Rendering Systems: Visual Methods.		
	Self-learning topics: Ray tracing and real-time rendering in VR, Use of game engines (Unity, Unreal) for AR/VR, AI-driven rendering and object recognition in AR		
04	**Interaction and Experience of Virtual world:**	07	**CO4**
	User Interface Metaphors, manipulating a Virtual World: Properties, Operations, navigating in a Virtual world, Way finding and Travelling, Interacting with the VR System, Rules of the Virtual World.		
	Self-learning topics: Human factors and ergonomics in VR systems, Designing intuitive VR navigation metaphors, Cognitive load and motion sickness prevention techniques		
05	**Building AR and VR Experiences:**	08	**CO5**
	Creating AR applications, integrating real-time camera feed and overlaying digital content, environmental understanding and spatial mapping in AR, designing VR environments and interactions, implementing VR user interfaces and navigation systems.		
	Self-learning topics: Cloud-based AR/VR and real-time collaboration, Integration with IoT and digital twins, XR content pipelines using Unity's AR Foundation and WebXR		
06	**Augmented Reality Software and Mobile Augmented Reality:**	07	**CO6**
	Augmented Reality Systems, Software Components, Interaction in Augmented Reality, Augmented Reality Techniques, Mobile Augmented Reality.		
	Self-learning topics: Marker-based vs. markerless AR, ARKit and ARCore development overview, WebAR technologies and lightweight AR experiences		
	Total	**42**	

Books Recommended:

Text books:

1. Complete Virtual Reality and Augmented Reality Development with Unity
2. Jesse Glover, Jonathan Linowes, Packt Publishing Limited, ISBN-13 978-1838648183, 2019.
3. Alan B Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann Publishers, ISBN:978-0240824086, 2013
4. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press,

2003/2006.
5. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design”, (The Morgan Kaufmann Series in Computer Graphics), Morgan Kaufmann Publishers, San Francisco, CA, 2002.

Reference Books:

1. Reality+: Virtual Worlds and the Problems of Philosophy, David J. Chalmers WW Norton Publisher, ISBN-13 978-1324050346, 2023.
2. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, “Augmented Reality: Principles & Practice”, Pearson Education India; First edition, ISBN-10: 9332578494, 12 October 2016)
4. Steven M. LaValle, “Virtual Reality”, Cambridge University Press, 2016
5. Sanni Siltanen, “Theory and applications of marker-based augmented reality”, Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

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
CEPEC6014	Data Science & Visualization	20	20	60	1	2	100	

Prerequisite: Machine Learning concepts, Engineering mathematics (linear algebra, probability, statistics)	
Course Objectives: The course aims to	
1	To introduce students to the basic concepts of data science.
2	To analyse the data by using various statistical and data mining approaches and to acquire an in-depth understanding of data exploration and data visualization.
3	To study different data visualization techniques and tools
4	To be familiar with various methodologies and evaluation strategies.
Course Outcomes: Learners will be able to	
1	To gain fundamental knowledge of the data science process and visualization
2	Apply descriptive and inferential statistics for hypothesis-driven insights.
3	To apply data exploration and visualization techniques.
4	Experiment with data visualization tools (Power BI)
5	Apply different methodologies and evaluation strategies.
6	Demonstrate advance understanding of Time series concepts and analysis of data using various time series models.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Data Science & Visualization:** Definition and scope of Data Science, Data Science Life Cycle, Applications and domains of Data Science, Comparison with other fields like Business Intelligence (BI), Artificial Intelligence (AI), Machine Learning (ML) Data Types and Sources: Different types of data: structured, unstructured, semi-structured, Data sources: databases, files, APIs, web scraping, sensors, social media Data Preprocessing: Data cleaning: handling missing values, outliers, duplicates, Data transformation: scaling, normalization, encoding categorical variables, Feature selection: selecting relevant features/columns, Data merging: combining multiple datasets, Data wrangling techniques: reshaping, pivoting, aggregating. Role of Data Visualization in Analysis and Decision Making, Data Visualization Fundamentals.	08	**CO1**

	Self-learning topics: Introduction to popular libraries and technologies used in Data Science like Pandas, NumPy, Sci-kit Learn, etc.		
02	**Exploratory Data Analysis (EDA)** Descriptive Statistics: Univariate Exploration: Measure of Central Tendency (Methods to calculate Arithmetic Mean, Weighted Mean, Median, Mode) Measure of Dispersion (Range, Quartile Deviation, IQR), Measures of Skewness (Karl Pearson Coeff. of skewness, Bowley's Coefficient of skewness), Measures of Kurtosis. Multivariate Exploration: Concept of Correlation, Correlation Analysis, Different forms of correlation, Karl Pearson Correlation Coefficient for bivariate distribution. Inferential Statistics: Normal distributions, Hypothesis testing - one sample and two samples, confidence interval for estimates, Type-I, Type-II Errors, ANOVA	08	**CO2**
03	**Basics of Data Visualization** Introduction to data visualization, challenges of data visualization, Definition of Dashboard, their type, Evolution of dashboard, dashboard design and principles, display media for dashboard. Types of Data visualization: Univariate Visualization: Histogram, Quartile, Distribution Chart, Multivariate Visualization: Scatter Plot, Feature correlation heatmaps, Scatter Matrix, Bubble chart, Density Chart, advanced visualization Techniques like streamline and statistical measures, Plots, Graphs, Networks, Hierarchies, Reports. **Self-Learning Topics:** Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	08	**CO3**
04	**Power BI for Data Visualization and Dashboard Creation:** 4.1 Introduction to Power BI: Interface, data connection, roles. Creating Basic Visualizations: Bar charts, line charts, scatter plots., Building Interactive Dashboards: Design principles, combining visualizations. Effective Data Storytelling using Power BI	04	**CO4**
05	**Evaluation methodology of Data Science:** Overview of model building, Experimental setups, training, tuning, test data, holdout method, cross-validation, k-fold cross validation, bootstrap method, Feature selection and dimensionality reduction (PCA), Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression. Outliers, Causes of Outliers, Outlier Detection using Statistics ((IQR, Z-score, boxplot methods), Outlier Detection using distance-based method and density-based method and SMOTE technique. **Self-learning topics:** Evaluation parameters for Classification, regression and clustering.	06	**CO5**

06	**Time Series Forecasting and Visualization** Time Series Basics: Definition and characteristics of time series data, Components: Trend, Seasonality, Cyclic, Irregular, Decomposition: Additive and Multiplicative models, Forecasting techniques: Moving Average, Exponential Smoothing, ARIMA. Time Series Evaluation and Visualization: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error, Time-series visualization: Line charts, Rolling mean, Seasonality plots, Autocorrelation plots.	08	**CO6**

Text Books:

1. Data Science from Scratch First Principles with Python- Joel Grus O'reilly, 2nd Edition
2. Vijay Kotu, Bala Deshpande. "Data Science Concepts and Practice", Elsevier, M.K. Publishers.
3. Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, "Comprehensive Statistical Methods", S.Chand Publications, New Delhi.
4. Data Visualization with Power BI by Daniel Murray

References:

1. Rachel Schutt and Cathy O'Neil, —Doing Data Science‖, O'Reilly Media
2. Forecasting : methods and applications- Spyros G Makridakis, Steven C wheelwright, Rob J Hyndman, 3rd edition Wiley publications
3. S.C. Gupta, V. K. Kapoor "Fundamentals of Mathematical Statistics", S. Chand and
4. Sons, New Delhi.
5. Data Storytelling with Power BI by Anupam Jain
6. online nptel link https://onlinecourses.nptel.ac.in/noc21_cs69/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 on Applications of Data Science : 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
CEPEC6021	Quantum Computing	20	20	60	1	2	100	

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming	
Course Objectives: The course aims to	
1	To understand fundamentals of quantum computing.
2	To understand mathematics required for quantum computing.
3	To understand building blocks of quantum computing and design algorithms.
4	To understand quantum hardware principles and tools for quantum computing.
Course Outcomes: Learners will be able to	
1	Describe building blocks of quantum computing through architecture and programming models.
2	Appraise various mathematical models required for quantum computing.
3	Explain architecture of a Quantum Computing platform.
4	Apply various quantum algorithms.
5	Identify various quantum hardware building principles.
6	Summarize tools for quantum computing.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamentals Quantum Computing** Motivation for studying Quantum Computing Origin of Quantum Computing Quantum Computer vs. Classical Computer Introduction to Quantum mechanics Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement **Self-Learning Topics:** Detail of Quantum computing and its applications	7	**CO1**
02	**Mathematical Foundations for Quantum Computing** Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	6	**CO2**
03	**Building Blocks for Quantum Program**		

	Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits.	8	**CO3**
04	**Quantum Algorithms and Error correction** Quantum Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm Quantum error correction using repetition codes 3-qubit codes, Shor's 9-qubit error correction Code **Self-Learning Topic:** IBM Quantum Composer	8	**CO4**
05	**Quantum Hardware** Ion Trap Qubits, The DiVincenzo Criteria, Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits	10	**CO5**
06	**Quantum Computing Platforms** IBM Quantum, Microsoft Azure Quantum, and Righetti Computing **Self-Learning Topics:** QVM vs. QPU	3	**CO6**

Text Books:

1 Michael A. Nielsen, —Quantum Computation and Quantum Information‖, Cambridge University Press.
2 David McMahon, —Quantum Computing Explained‖, Wiley ,2008
3 Qiskit textbook https://qiskit.org/textbook-beta/
4 Vladimir Silva, Practical Quantum Computing for Developers,2018

References:

1 Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
2 Supriyo Bandopadhyay and Marc Cahy, —Introduction to Spintronics, CRC Press, 2008
3 The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-

Technologies, Lars Jaeger
4 La Guardia, Giuliano Gladioli —Quantum Error correction code, Springer,2021

Digital References:

https://onlinecourses.nptel.ac.in/noc19_cs47/preview
https://www.coursera.org/courses?query=quantum%20computing
https://www.cl.cam.ac.uk/teaching/1617/QuantComp/

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
CEPEC6022	Human Machine Interaction	20	20	60	1	2	100	

Prerequisite: Basic knowledge of computer science, Web Technologies, Software Engineering, Human psychology, designing tools and languages like HTML, Java, etc.	
Course Objectives: The course aims to	
1	Learn the foundation of human machine interaction.
2	Understand the importance of human psychology in designing good interfaces.
3	Understand various design technologies to meet user requirements
4	Apply an interactive design process and universal design principles in real world HCI systems.
Course Outcomes: Learners will be able to	
1	Understand the fundamental aspects of user interfaces designing.
2	Apply Interactive Design process in real world applications.
3	Apply core principals of user interface design to create user centred graphical and web based interfaces.
4	Design clear and efficient screen navigation and flow for improved usability.
5	Design interactive components for windows.
6	Apply techniques to design interfaces for mobile applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to HMI** Importance of user Interface – definition, importance of good design. Benefits of good design, History of User Interface Designing, Overview of Human–Computer Interaction (HCI) vs Human–Machine Interaction (HMI) Human interaction with computers, importance of human characteristics, human consideration, Human interaction speeds understanding business junctions. The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning	4	**CO1**

	and problem solving. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.		
02	**Design and Process** HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process. Design Evaluation: Universal Design, Expert analysis and user participation **Self-learning Topics:** Data Driven and AI-Assisted Design	8	**CO2**
03	**Graphical User Interface** The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design. **Self-learning Topics**: Advance interaction techniques like Multimodal interaction (speech, gesture, haptics)	8	**CO3**
04	**Screen Designing** Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow. Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully information retrieval on web, statistical graphics. Technological consideration in interface design.	8	**CO4**
05	**Interaction Styles and Communication** Windows: Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia and colors Ethical and privacy considerations in HMI. **Self-learning Topics:** Advance Interface design tools (Figma, Adobe XD, Balsamiq)	7	**CO5**
06	**Interface Design** Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. Case Studies: Healthcare, Education **Self-learning topics:** Applications (HMI in autonomous vehicles, robotics)	7	**CO6**

Textbooks:	
1	Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, —Human Computer Interaction, 3rd Edition, Pearson Education, 2004

2	Wilbert O. Galitz, —The Essential Guide to User Interface Design‖, Wiley publication.
3	Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education.
4	Brian Fling, —Mobile Design and Development‖, First Edition, O'Reilly Media Inc., 2009
References:	
1	Rogers Sharp Preece, Interaction Design: Beyond Human Computer Interaction, Wiley
2	Guy A. Boy —The Handbook of Human Machine Interaction, Ashgate publishing Ltd.
3	online nptel link

Assessment: -
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/Oral examination/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

C. 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
CEPEC6023	Advance Algorithm & Complexity	20	20	60	1	2	100	

Prerequisite: Data structures, Discrete mathematics and Analysis of Algorithm	
Course Objectives: The course aims to	
1	Analyze and design efficient algorithms using advanced techniques.
2	Apply suitable data structures and algorithmic paradigms to solve problems.
3	Understand computational geometry and complexity classes of problems.
Course Outcomes: Learners will be able to	
1	Analysis of Recursive and Amortized Algorithms
2	Apply probabilistic and randomized methods in algorithms
3	Implement and analyze advanced tree and heap structures.
4	Apply network flow algorithms for max flow and matching.
5	Solve geometric problems using efficient algorithms.
6	Classify and compare P, NP, NP-Hard, and NP-Complete problems.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Fundamental of Algorithms** Complexity of recursive algorithms, finding complexity by Recursion tree method, master method Amortized analysis - aggregate analysis, accounting analysis, potential analysis	04	**CO1**
02	**Probabilistic Analysis and Randomized Algorithm** Probabilistic Analysis - The hiring problem, Indicator random variables Randomized algorithms – Las Vegas Algorithm, Monte Carlo Algorithm	05	**CO2**
03	**Advanced Data Structure** B Trees, B+ Trees: Operations on B Trees and B+ Trees Red-Black Trees: Properties of red-black trees, Operations on Red-black trees	12	**CO3**

	Splay Trees: Rotations, Operations on Splay Trees Binomial Heaps: Min and Max heap properties, Binomial trees and binomial heaps, Operations on Binomial heaps Analysis of all above operations		
	Self-Learning Topics: Tries, Fibonacci Heap		
04	**Maximum Flow** Flow networks, the Ford Fulkerson Algorithm, Max Bipartite Matching, Push Relabel Algorithm, The Relabel to Front algorithm	09	**CO4**
05	**Computational Geometry** Line Segment properties, determining whether any pair of segments intersects – Sweep Line algorithm, finding the convex hull – Graham's Scan algorithm, Finding the closest pair of points using divide and conquer algorithm	07	**CO5**
06	**Complexity Class** P, NP, NP-Hard, NP-Complete classes, The vertex- cover problem, The travelling salesman problem, The set-covering problem	05	**CO6**

Textbooks:	
1	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, 3rd Edition, MIT Press, 2009.
2	Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson Education, 2006.
3	Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Galgotia Publications, 2008.
References:	
1	Sanjoy Dasgupta, Christos Papadimitriou, and Umesh Vazirani, Algorithms, McGraw-Hill Education, 2008.
2	Aho, Hopcroft, and Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley, 1974.
3	https://onlinecourses.nptel.ac.in/noc25_cs153/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
CEPEC6024	Social Media Analytics	20	20	60	1	2	100	

Prerequisite: Basic knowledge of data mining, data analytics, graphs, and programming in Python or R.	
Course Objectives: The course aims to	
1	To understand key concepts and characteristics of social media and networks.
2	To learn methods to collect, analyze, and visualize social media data.
3	To explore text, action, hyperlink, and location-based social media analytics.
4	To apply network measures and visualization for analyzing social connections and influence.
5	To study social information filtering and recommendation techniques.
6	To examine applications of social media analytics in business and public sectors with emphasis on privacy and ethics.
Course Outcomes: Learners will be able to	
1	Understand concepts and characteristics of social media and networks.
2	Analyze and interpret social media data.
3	Explain text, action, hyperlink, and location analytics.
4	Apply network measures and visualization techniques.
5	Describe social filtering and recommendation systems.
6	Evaluate social media analytics applications with emphasis on privacy and ethics.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Social Media Analytics: An Overview** Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools **Self-learning topics:** Compare traditional and social media analytics in	7	CO1

	terms of data and insights. Study one popular social media analytics tool and its key applications.		
02	**Social Network Structure, Measures & Visualization** Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools. **Self-learning topics:** Analyze a small social media network dataset and interpret key measures (degree, density, centrality). Visualize a network using Gephi or NetworkX and explore layouts and node sizing.	7	**CO2**
03	**Social Media Text, Action & Hyperlink Analytics** Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools, Social Media Action Analytics - What Is Action Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools **Self-learning topics:** Review tools used for text, action, and hyperlink analytics. Study real-world applications of these analytics in business or marketing contexts.	7	**CO3**
04	**Social Media Location & Search Engine Analytics** Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools **Self-learning topics:** Study applications of location analytics in business and marketing. Review popular tools used for search engine and location analytics**.**	6	**CO4**
05	**Social Information Filtering** Social Information Filtering - Social Sharing and filtering, Automated Recommendation systems, Traditional vs. Social Recommendation Systems, Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks **Self-learning topics:** Study how a social media platform uses social filtering in recommendations. Identify key KPIs from a real campaign and link them to business goals.	8	**CO5**
06	**Social Media Analytics Applications and Privacy** Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study— privacy - Privacy policies, data ownership and maintaining privacy online.	7	**CO6**

	Self-learning topics: Study a public sector or business social media campaign and its success metrics. Review one social media privacy or data ownership case.		

Text Books:

1. Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
2. Analyzing the Social Web 1st Edition by Jennifer Golbeck
3. Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

References:

1. Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2. Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3. Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6
4. https://nptel.ac.in/courses/106106146

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
CEPEL6011	Internet of Things Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	To study fundamental concepts of IoT
2	To understand the key requirements for implementing IoT with Arduino Uno and Raspberry Pi development boards
3	To understand use of sensors and actuators for design of IoT
4	Able to design and build Application of IoT in Industrial and Commercial Automation and Real-World Design Constraints
Course Outcomes: Learners will be able to	
1	To understand the various concepts, terminologies and architecture of IoT
2	Deploy Raspberry Pi and Arduino for designing the IoT applications.
3	Demonstrate the working of sensors, actuators based on the collected data
4	Deploy an IoT application and connect to the cloud.

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Basics of Internet of Things: Sensors, Actuators, IoT architecture and Gateway	CO1
02	Basic IoT setup with Arduino-uno or Raspberry Pi and ESP8266	CO2
03	Write an Arduino program to demonstrate data types, variables, constants, operators, if statements, switch case, loops, arrays.	CO2
04	To study and understand the working of the MQTT (Message Queuing Telemetry Transport) protocol, its architecture, and its role in IoT (Internet of Things) communication.	CO2
05	Interface temperature sensor LM35 with Arduino. Display the temperature and the corresponding voltage	CO3
06	Develop a program to deploy a smart street light system using an LDR sensor.	CO3
07	Develop a program to read the pH value of various substances like milk, lime and water.	CO3

08	Write a IoT based Program on Raspberry pi (Case study of LED control) Write a basic program (i.e. html code) in a PC for creating command buttons on a browser window. Write and upload the Arduino code for ON/OFF control of LED. Run the program of Arduino and give the browser-based command to control the LED	CO2, CO3
09	Case study on IoT Applications like Home Automation: This home automation system based on IoT automates the functioning of household appliances over the Internet. Smart Agriculture System: This IoT-based system performs the routine agricultural tasks automatically and allows farmers to focus on more labor-intensive tasks. Implementation of a smart irrigation System, Smart dustbin, Intelligent Building, Smart harvesting, Smart Hospital, Smart classroom, Smart transportation/traffic, Smart Museum etc.	CO4

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
CEPEL6012	Wireless Network Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	To understand the principles and evolution of modern wireless communication systems.
2	To study wireless protocols, modulation techniques, and multiple access schemes through simulation.
3	To analyze MAC layer issues and routing protocols in wireless networks using simulators.
4	To explore 4G, 5G, WLAN, and PAN technologies via simulation and modeling.
5.	To evaluate wireless network performance and security mechanisms through case studies.
Course Outcomes: Learners will be able to	
1	Model and simulate wireless communication environments using NS2/NS3
2	Implement and analyze MAC and routing protocols in ad hoc and sensor networks
3	Evaluate performance metrics like throughput, delay, and packet loss in simulated wireless systems.
4	Demonstrate understanding of LTE, 5G, and IoT networks using simulation tools.
5	Analyze wireless security mechanisms and simulate attacks and defences using Wireshark.

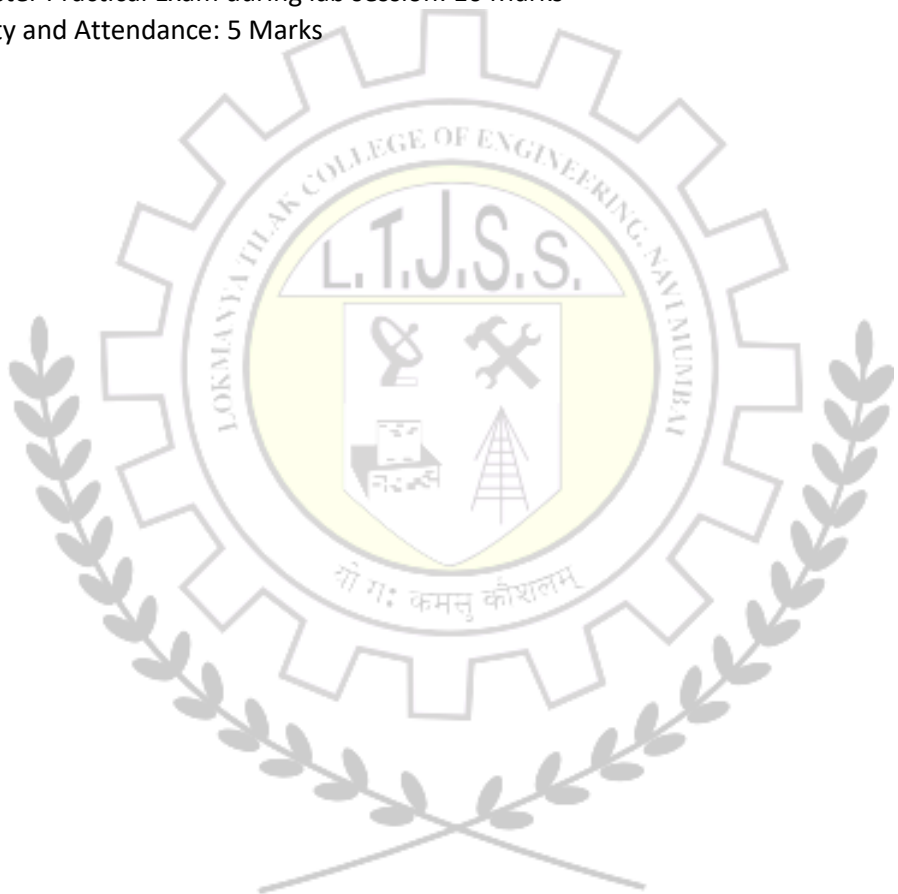
Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study of Wireless Network Simulation Tools (NS2/NS3, Wireshark, Packet Tracer).	CO1
02	Study of wireless devices, topologies, and standards (WLAN, PAN, MANET).	CO1
03	Simulation of a Basic Wireless LAN (IEEE 802.11).	CO1
04	Implementation of CSMA/CA Protocol in NS2/NS3.	CO2, CO3
05	Compare MACs: CSMA/CA vs TDMA vs 802.15.4	CO2, CO3
06	Configure a WLAN and capture packets using Wireshark.	CO3
07	Comparative Study of Wired vs Wireless Network Performance in NS2/NS3	CO4
08	Simulation of Bluetooth and ZigBee Networks using NS3.	CO3

09	Modeling and Simulation of Wireless Sensor Network (WSN) Topology.	CO1
10	Implement Mobile IP using simulation tools	CO4
11	Simulation of LTE network with multiple users	CO4
12	Simulation of Wireless Security Protocols (WEP, WPA2) using Wireshark.	CO5
13	Case study on wireless network performance and security mechanisms	CO5

Continuous Internal Evaluation (25 Marks)

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



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
CEPEL6013	**Augmented and Virtual Reality Lab**	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Understand the fundamentals of Augmented Reality (AR) and Virtual Reality (VR) technologies, including hardware, software, and interaction paradigms.
2	Develop skills in designing, modeling, and implementing immersive applications using AR/VR development tools (e.g., Unity, Unreal Engine, ARCore, ARKit, Vuforia).
3	Explore human-computer interaction (HCI) in immersive environments and evaluate user experience in AR/VR systems.
4	Integrate computer vision, 3D graphics, and sensor technologies to create interactive and context-aware AR/VR systems.
Course Outcomes: Learners will be able to	
1	Demonstrate understanding of the basic principles and components of AR and VR systems
2	Integrate computer vision and 2D/3D graphics to create interactive and context-aware AR/VR systems, geometric transformations, and simple VR scenes.
3	Develop skills in designing, modeling, and implementing immersive applications using AR/VR development tools (e.g., Unity, Unreal Engine, ARCore, ARKit, Vuforia).
4	Design and deploy AR/VR applications integrating input tracking, spatial mapping, gesture recognition, and 3D sound for immersive experiences.
5	Apply AR/VR solutions to real-world domains such as education, healthcare, manufacturing, architecture, entertainment, and simulation.

Suggested Experiments: Augmented Reality and Virtual Reality Lab		
Sr. No.	**Suggested Experiments**	**CO Mapping**
1.	Write a simple Python script to display 360° panoramic images using OpenCV. • Use matplotlib or pygame to visualize immersive 2D environments. • Simulate head movement by mapping mouse movement to image rotation.	**CO1**
2.	Create basic 2D/3D shapes using PyOpenGL or VPython. • Implement geometric transformations (rotation, scaling, translation) using numpy arrays. • Visualize lighting and color effects on simple objects using matplotlib 3D plots.	**CO2**
3.	Build a simple VR environment using PyOpenGL or Panda3D.	**CO2**

	• Simulate head movement and field of view changes in a 3D scene. • Use sound device or pygame.mixer to add 3D positional sound effects.	
4.	Use OpenCV and ArUco markers to create a marker-based AR system. • Detect faces or hands using a mediapipe and overlay 3D objects on them. • Overlay text, images, or 3D shapes on a live webcam feed. • Build a simple object-tracking AR demo using color segmentation.	**CO3**
5.	Design a simple 3D scene using Blender's Python API (bpy). • Automate texture or object placement with bpy scripting. • Use Python to control object movement or scene logic via scripting.	**CO3**
6.	Demonstration of the working of a Virtual Reality (VR) System (HTC vive) using (Google Daydream or Samsung gear VR)	**CO3**
7.	Develop and deploy a simple marker-based AR app in which you have to write a program to play video on tracking a particular marker.	**CO4**
8.	Develop and deploy an AR app, implement the following using any Engine developer portal: • Plane detection • Marker based Tracking (Create a database of objects to be tracked in Vuforia • Object Tracking	**CO4**
9.	Study and Implementation Gesture recognition and interaction	**CO4**
10.	Simulate surgical procedures or visualize anatomical structures in AR	**CO5**

Continuous Internal Evaluation (25 Marks)

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

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
CEPEL6012	Data Science & Visualization Lab	-	25	-	-	-	25	

Prerequisite: Basic programming (preferably Python), Engineering mathematics (linear algebra, probability, statistics)	
Course Objectives: The course aims to	
1	To explore various stages in the data science lifecycle.
2	To understand data preparation, exploration and visualization techniques.
3	Develop proficiency in data visualization techniques and tools to effectively communicate insights and tell compelling stories using data.
4	Learn how to evaluate and select models using appropriate evaluation metrics and cross validation techniques to ensure reliable and robust model performance
Course Outcomes: Learners will be able to	
1	Apply various stages of the data science lifecycle for the selected case study.
2	Demonstrate data preparation, exploration and visualization techniques.
3	Create informative and visually appealing data visualizations to communicate insights and patterns in data.
4	Evaluate and compare different machine learning models using appropriate evaluation metrics and cross-validation techniques

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Data Preprocessing and Data cleaning • Read data from CSV and JSON files into a data frame. • Perform basic data pre-processing tasks such as handling missing values and outliers and Apply data cleaning techniques (e.g. Data Imputation). • Manipulate and transform data using functions like filtering, sorting, and grouping.	CO1
02	Explore the descriptive and inferential statistics on the given dataset. • Frequency distribution • Descriptive Statistics: Measures of Central Tendency and Variance, Poisson distribution • Hypothesis testing using Z test or t test • Perform one-way ANOVA to compare means across multiple groups	CO1, CO2

03	Use Netflix Movies and TV Shows dataset from Kaggle and perform following operation: • Make a visualization showing the total number of movies watched by children • Make a visualization showing the total number of standup comedies • Make a visualization showing the most watched shows. • Make a visualization showing highest rated show • Make a dashboard (DASHBOARD A) containing all of these above visualizations • Combine multiple visualizations to tell a compelling data story	CO1, CO3
04	Introduction to data visualization setup tools. Install Data Analysis and Visualization tools: Power BI and working with basic report design and visualization.	CO3
05	Perform Outlier detection using distance based/density based method.	CO4
06	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning) • Build a logistic regression model to predict a binary outcome. Evaluate the model's performance using classification metrics (e.g., accuracy, precision, recall) • Apply the K-Means algorithm to group similar data points into clusters. Determine the optimal number of clusters using elbow method or silhouette analysis. Visualize the clustering results and analyze the cluster characteristics	CO4
07	Implement time series forecasting. (example Weather data, Rainfall measurements)	CO1, CO4
08	Implementation of ARIMA model in python	CO4
09	Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study) sample case studies: 1. Customer Segmentation 2. Fraud Detection 3. House Price prediction 4. Product Recommendation	CO1, CO2, CO3, CO4

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
CECEP601	Mini Project II	-	25	25	-	-	50	

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

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

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

Project Guidance and Evaluation Framework:

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

Continuous Internal Evaluation (25 Marks)

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

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

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

Oral/ Practical Exam (25 Marks)

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

References for Project:

https://www.guvi.in/blog/top-mini-project-ideas-for-college-students/

https://www.geeksforgeeks.org/project-idea-college-network/?ref=ml_lbp

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

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

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

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

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

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

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

https://roadmap.sh/projects

Multidisciplinary Minor Course III

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

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

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Big data Analytics** Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	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**		

	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	7	**CO3**
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 Map Reduce.	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**
	Total	**42**	

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

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

Suggested List of Experiments

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

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

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

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

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

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 topics:** 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						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETMDML601	Digital Image Processing Lab	-	25	-	-	-	25	

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

Suggested List of Experiments

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

Sr. No.	List of Experiments	CO Mapping
01	Perform Image reading, displaying, and writing	CO1
02	Perform Image transformations like rotation, scaling, and translation	CO1
03	Implement Histogram equalization	CO2
04	Implement Spatial Domain Filtering: Smoothing and Sharpening Filters	CO2
05	Implement Frequency domain filtering: Low-pass and High-pass Filters	CO2
06	Implement Edge based segmentation- Sobel, Prewitt, Laplacian, and Canny operators	CO3
07	Implement region growing and watershed segmentation	CO3
08	Image segmentation using global Thresholding Algorithm	CO3
09	Implement RLE and Huffman coding for images	CO4
10	Implement Discrete Cosine Transform	CO4
11	Implement Wavelet transform	CO4

12	Implement Morphological operation – Erosion and Dilation, Opening and Closing operations, Hit-or-Miss transform, Boundary Extraction and Region Filling, Thinning and Thickening	CO5
13	Compute region and shape descriptors for given images	CO5
14	Perform object detection	CO6
15	Case Study on applications of Image Processing	CO6

Continuous Internal Evaluation (25 Marks)

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

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

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

	characteristics of robot.		
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, Soft robotics.	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						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ARMDML601	Robotics Lab	-	25	-	-	-	25	

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

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.	CO1
02	Study different coordinate frames and transformations. Using Open Ware simulation software. Steps: Define the base and tool coordinate frames. Perform homogeneous transformations. Visualize transformed points in Open Ware. Results: Record transformed coordinates.	CO2
03	Program a robotic arm to perform pick-and-place tasks. Apparatus: Educational robotic arm with Open Ware interface. Procedure: Identify pick and place coordinates. Write program using Open Ware commands. Execute and observe operation. Results: Successful pick-and-place operation	CO3
03	Edge detection using image processing (simulation/hardware) Result: Edges in the image successfully detected using gradient-based algorithms.	CO4

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

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

Continuous Internal Evaluation (25 Marks)

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

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

Prerequisite: Digital Electronics, Number system	
Course Objectives: The course aims to	
1	understand the features and architecture of PIC 18 microcontroller and Ardino UNO
2	Introduce assembly programming knowledge for PIC 18 microcontroller
3	Impart embedded programming knowledge for PIC 18 microcontroller using C
4	Introduce various applications using microcontroller-based system
Course Outcomes: Learners will be able to	
1	Explain difference between microprocessor and microcontroller architecture and memory
2	Understand PIC 18 instruction and assembly level Programming
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 Ardino UNO programming
6	Write C program for various application of microcontroller.

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) *CPU registers:* Working Register (Wreg), Status Register, Bank Select Register (BSR), Instruction Decoder *Memory Pointers:* Program ROM and Program Counter (PC), Data ROM	6	**CO1**
02	**PIC18F Instruction Set** Pipelining. (conceptual overview only) *Instructions and Assembly Programs:* Instruction Set, Instruction formats, Addressing modes, Assembler Directives, Assembly programs. (Assembly programs are restricted to basic arithmetic, logical and data transfer operations only)	9	**CO2**
03	**PIC 18 Timer/counters and interrupt**		

	Timer Module: Basic Concept of Timers and counters, Timer Registers, Control Registers, 8 bit and 16 bit operation (only for Timer 0), CCP module (Capture, Compare and PWM), Watch dog Timer. *Interrupt Module:* Basic concept of Interrupt, PIC 18 Interrupts, Interrupt versus polling, Interrupt sources, Interrupt vector, Interrupt service routine, Interrupt process, RCON, INTCON, IPR1 and PIE1.	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 Ardino** Intoduction to Ardino -UNO board, Analog and digital Pins, Programming structure of Ardino, basics of C programming, programming Ardino 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.	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 Ardino: Getting started from Sketches, second Edition,

Reference Books:-

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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 Hours
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ITMDML601	Microcontrollers and Application Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Impart assembly programming of PIC microcontroller
2	Impart assembly programming for I/O interface and timer, counter
3	Impart knowledge of Ardino 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
4	Write and debug Ardino programs
5	Write and debug I/O programming of Ardino and PIC
6	Make system using microcontroller

Suggested List of Experiments

Minimum three experiments must be done from each group

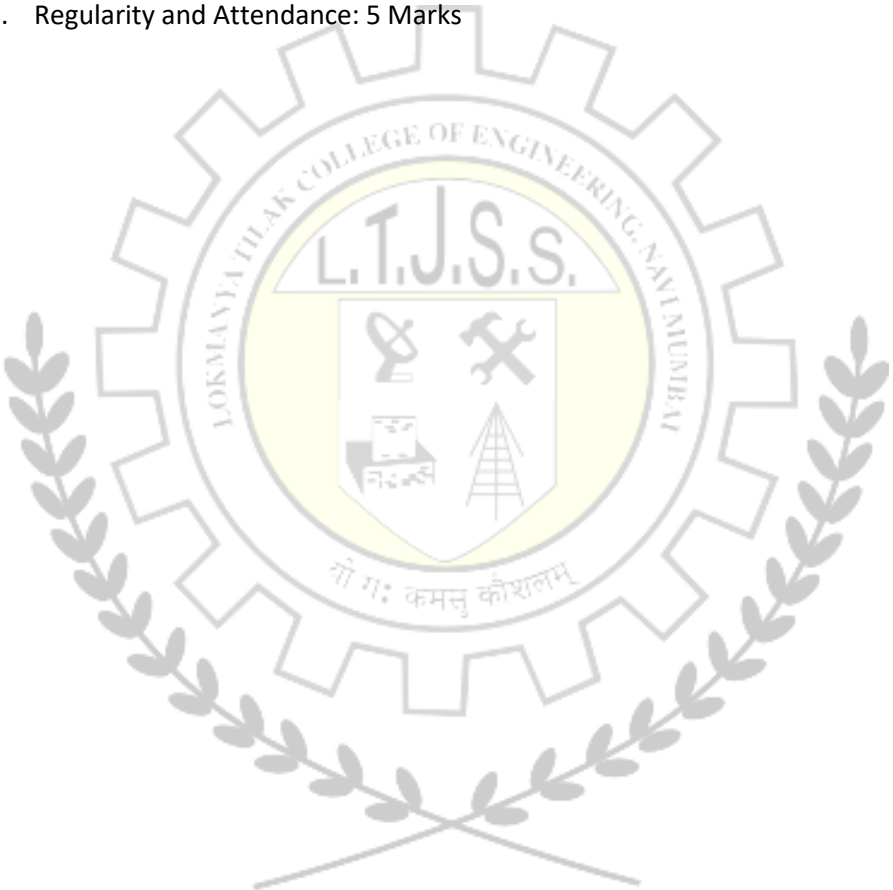
Sr. No.	List of Experiments	CO Mapping
Group A	Use at least 3 programs 1. Data transfer 2. Group of data transfer 3. Addition, Subtraction, Multiplication 4. Time delay 5. Conditional and unconditional tasks	CO1
Group B	1. Square wave generation 2. LED inter facing 3. Blinking LED 4. Serial port programming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

Group C	1. Simple ardino programming for addition subtraction 2. Ardino programming for LED blinking 3. PIC 18 programming for LCD interface 4. PIC 18/Ardino programming for DC motor interface 5. Any other application of Microcontroller	CO2

Minimum 9 experiments and case study hardware project and one assignment are compulsory for the term work.

Continuous Internal Evaluation (25 Marks):

1. Lab Performance: 10 Marks
2. Mid Semester Oral & Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 5 Marks



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

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

Module	Detailed Contents	Hrs.	CO Mapping
01	**Clutch and Transmission Systems** a) Purpose of clutch & transmission in a vehicle b) Single-plate, multi-plate clutches, centrifugal clutches c) Manual transmissions: sliding mesh, constant mesh, synchromesh d) Automatic transmissions: torque converter, fluid coupling e) Continuously Variable Transmission (CVT) f) Introduction to EV / hybrid transmission layouts	07	**CO1**
02	**Driveline, Final Drive & Differential**		

	a) Driveline components: propeller shaft, universal joints, driveshafts b) Final drive gears & bearings c) Differential: open, limited slip, locking types d) Rear axle construction for different vehicles (2WD, 4WD) e) Introduction to EV/Hybrid drivetrain configurations (e.g., single motor, dual motor, hub motors)	08	**CO2**
03	**Steering, Wheels, Tyres & Suspension** a) Steering geometry, types of steering mechanisms (rack & pinion, recirculating ball) b) Power steering systems, steer-by-wire c) Tyre construction, types, loads; wheel & hub assembly d) Suspension systems: leaf, coil, air, independent suspension e) Vehicle dynamics basics: camber, toe, roll, pitch f) EV/HV implications: regenerative braking effect on suspension, weight distribution, hub motors	08	**CO3**
04	**Braking Systems & Chassis Layout** a) Braking fundamentals: friction brakes, drum vs disc b) Hydraulic and pneumatic braking systems c) ABS, EBD, regenerative braking (in EV/HV) d) Chassis types: ladder, monocoque, space-frame e) Vehicle layouts: FR, FF, MR, RR, 4WD, AWD f) Impact of EV architecture on chassis-body design (battery placement, low centre of gravity)	07	**CO4**
05	**Vehicle Body, Aerodynamics, Materials** a) Vehicle body structures, loads, crashworthiness b) Aerodynamics basics: drag, lift, side-wind, airflow c) Materials in automotive industry: steels, aluminium, composites d) Integration of thermal management systems for EV	05	**CO5**
06	**Electric & Hybrid Vehicle Systems**		

	a) Overview of electric vehicle (EV) and hybrid architectures b) Batteries: types, performance metrics c) Electric motors / motor drives: types (DC, AC, PMSM, etc.) d) Power electronics: inverters, converters, charger systems e) Charging infrastructure, vehicle-to-grid (V2G) & future trends f) 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)

4. Assignment: 5 Marks
5. Quiz/Visit/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 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
MEMDML601	Automobile Lab	-	25	-	-	-	25	

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

Suggested List of Experiments

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

06	Study of EV architecture – components like battery, motor, inverter, and charging systems.	CO6

Continuous Internal Evaluation (25 Marks)

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

Course Code	Course Name	Examination Scheme						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	To describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
2	To identify and describe the principles of various EV/HEVs drive train topologies.
3	Develop a 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	To Model, analyze and design EV/HEV drive train with energy management
6	To recognize the need to adapt and engage in operations EV/HEV with the absolute technological change in the transportation system for sustainable future.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction** 1.1 Basics of vehicle mechanisms, history of Electric V ehicles (EV) and hybrid electric vehicles (HEV), importance of EV and HEV. 1.2 Power/Energy supplies requirements for EV/HEV applications, transmission characteristics. 1.3 State of the art and Indian and global scenario in EV/HEV. **Self-Learning Topic: Basics of vehicle parts, Bharat standard for vehicle emission**.	06	**CO1**
02	**Drive train Topologies** 2.1 Common parts in ICE drive train and EV/ HEV electric drive train topologies, Classification of HEV (Micro, Mild and Full hybrid) 2.2 basics of hybrid traction system, various hybrid drive-train topologies 2.3 fuel efficiency analysis for series and hybrid drive train, comparision. **Self-Learning Topic: Electric motor, single and multi drive system,**	06	**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.	08	**CO3**
	Self-Learning Topic: comparison of DC and AC machines, induction motor drive characteristics.		
04	**Energy sources for EV and HEV**	08	**CO4**
	4.1 Requirements of energy storage in EV/HEV: batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV 4.2 Characteristics and comparison of energy sources for EV/HEV 4.3 hybridization of different energy sources.		
	Self-Learniing Topic: Basics of cell, overview of battery.		
05	**Drive train modeling in EV/HEV**	07	**CO5**
	5.1 Modeling and analysis of EV/HEV drive train: Total tractive force calculation, sizing of motor 5.2 Power electronics drive used in EV/HEV		
	Self-Learning Topic: Basic electronic components guidelines.		
06	**Energy management strategies in EV/HEV**	07	**CO6**
	6.1 EV/HEV energy management strategies, classification of various energy management strategies. Rule based EMS, optimization methods of EMS. 6.5 Standards for EV and HEV. Case studies.		
	Self-Learning Topic: 2w and 3w EV/HEV vehicles.		

Text Books:

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

Reference Books:

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

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
EEMDML601	**Electric Vehicle Technology Lab**	-	25	-	-	-	25	

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

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Basic vehicle simulations on Matlab or any other vehicle simulation software	CO1
02	Study of transmission system through simulation/ experiment	CO1
03	Emission test of conventional vehicle, electric vehicle and hybrid electric vehicle	CO2
04	Develop schematic diagram of hybrid electric vehicle and identify its parts in matlab simulation	CO2
05	Load test of DC series Motor	CO3
06	Testing and analysis of induction motor loading at different speed and torque condition.	CO3
07	Connect and run the three phase squirrel cage induction motors (in both directions) using the DOL starter/ autotransformer starter.	CO3
08	Rechargeable lithium-ion battery SOC test and other performance	CO4
09	Design and testing of controlled rectifier circuit for battery charging	CO4
10	Prepare a report on batteries used from market survey	CO4

11	study of battery management system through simulation/experiment	CO5
12	Design and testing of battery connected buck / boost converter	CO5
13	List safety procedures and schedule for handling HEVs and EVs	CO6
14	Case study- Compare minimum four vehicles for economic and environmental analysis	CO6
15	Visit to EV/Battery/Motor/Capacitor manufacturing Plant	All COs

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

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

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