Lokmanya Tilak College of Engineering

Sector 4, Vikas Nagar, Koparkhairane, Navi Mumbai 400709

An Autonomous Institute Affiliated to University of Mumbai

Department of Computer Science & Engineering

(Data Science)

Curriculum Structure for Third Year Engineering

Approved by Board of Studies on 27-04-26

Approved by Academic Council on 22-05-26

DEPARTMENT OF DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (Data Science)

CURRICULUM STRUCTURE FOR SECOND YEAR ENGINEERING PROGRAM

(Effective for 2026-2027)

Preamble

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, Electronics Engineering, Computer Science & Engineering (Data Science), Computer Science & Engineering (Artificial Intelligence & Machine Learning) and Computer Science & Engineering (IoT & Cyber Security Including Blockchain Technology). Institute also offers Doctoral Programmes in Mechanical Engineering and Computer Engineering. LTCE stands steadfast in its mission of continuing efforts for the betterment of its students and society.

The National Education Policy 2020, recently implemented by the Government of India, envisions providing quality education to all young people, with the primary goal of nurturing well-rounded, thoughtful, and creative individuals. NEP 2020 also emphasizes the importance of developing character, ethical values, constitutional principles, intellectual curiosity, scientific temper, creativity, and other related virtues. The Government of Maharashtra has instructed autonomous colleges to update their curriculum and begin implementing the National Education Policy (NEP) 2020. We are fully committed to ensuring the effective and meaningful adoption of NEP 2020 in its true essence. At "Lokmanya Tilak College of Engineering", the holistic development of learners has always been our top priority and central focus. LTCE embraced the NEP philosophy as early as 2022 wherein we have introduced the concept of Honors and Minors programs on emerging fields including AI & ML, Data Science, Cyber Security, IoT, Blockchain, etc., as per the guidelines of University of Mumbai and in 2024, we proudly graduated our first batch under this holistic curriculum. The 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. Nandini Chandra Nag	Dr. Sheeba P. S.	Dr. Subhash K. Shinde
BOS Chairperson, CSE (Data Science)	Dean, Academic & Research	Principal

Department of Computer Science and Engineering (Data Science)

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)		
DSPCC501	Artificial Intelligence	3		3		3	20	20	60	2		100
DSPCC502	Machine Learning	3		3		3	20	20	60	2		100
DSPCC503	Statistical Data Analysis and Visualization	3		3		3	20	20	60	2		100
DSPEC501x	Program Elective Course I	3		3		3	20	20	60	2		100
DSMDM501	Multidisciplinary Minor Course II	3		3		3	20	20	60	2		100
DSVSEC501	UI & UX Design		2*+2		2	2		50			25	75
DSPCL501	Artificial Intelligence & Machine Learning Lab		2		1	1		25			25	50
DSPCL503	Statistical Data Analysis and Visualization Lab		2		1	1		25			25	50
DSPEL501x	Program Elective Lab I		2		1	1		25			25	50
DSMDML501	Multidisciplinary Minor Lab II		2		1	1		25				25
Total		**15**	**12**	**15**	**6**	**21**	**100**	**250**	**300**	**10**	**100**	**750**

*** e-learning**

DSPEC501x **Program Elective Course** I	**DSPEC5011** Computer Network & Security	**DSPEC5012** Theory of Computation	**DSPEC5013** Nature Inspired Optimization Algorithms
DSPEL501x **Program Elective Lab**	**DSPEL5011** Computer Network & Security Lab	**DSPEL5012** Theory of Computation Lab	**DSPEL5013** Nature Inspired Optimization Algorithms Lab

Department of Computer Science and Engineering (Data Science)

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)		
DSPCC601	Deep Learning	3		3		3	20	20	60	2		100
DSPCC602	Software Engineering and Project Management	3		3		3	20	20	60	2		100
DSPEC601x	Program Elective Course I	3		3		3	20	20	60	2		100
DSPEC602x	Program Elective Course II	3		3		3	20	20	60	2		100
DSMDM601	Multidisciplinary Minor Course III	3		3		3	20	20	60	2		100
DSPCL601	Deep Learning Lab		2		1	1		25			25	50
DSPCL602	Software Engineering and Project Management Lab		2		1	1		25			25	50
DSPEL60X	Program Elective Lab		2		1	1		25				25
DSMDML601	Multidisciplinary Minor Lab III		2		1	1		25				25
DSCEP	Mini Project II		2		1	1		25			25	50
Total		**15**	**10**	**15**	**5**	**20**	**100**	**225**	**300**	**10**	**75**	**700**

DSPEC601x: Program Elective Course I	**DSPEC6011** Cloud and Distributed Networks	**DSPEC6012** Embedded System and IoT	**DSPEC6013** Graph Data Science
DSPEC602x: Program Elective Course II	**DSPEC6021** Social Network Analytics	**DSPEC6022** Recommendation System	**DSPEC6023** Explainable AI
DSPEL60x: Program Elective Lab	**DSPEL6011** Cloud & Computational Lab	**DSPEL6012** Computational Intelligence Lab	**DSPEL6013** Computational & Data Science Lab

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

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPCC501	Artificial Intelligence	20	20	60	1	2	100	

Prerequisite: Mathematics for Computer Science, Data Structures, Analysis of Algorithm	
Course Objectives: The course aims to	
1	Gain perspective of AI, its foundation and study different agent architectures and properties of the environment
2	Understand the basic principles of AI towards problem solving.
3	Overview of Machine Learning and Deep Learning concepts
4	Learn fundamental concepts of ANN
5	Introduced the fundamental concepts and core techniques of Advanced Artificial Intelligence
Course Outcomes: Learners will be able to	
1	Explain the fundamentals of AI and Identify the characteristics of the environment and differentiate between various agent architectures.
2	Apply the most suitable search strategy to design problem solving agents.
3	Gain basic concepts of Machine Learning and Deep Learning.
4	Gain basic knowledge of Neural Networks.
5	Design and develop AI applications in real world scenarios.
6	Explain and evaluate advanced artificial intelligence concepts and describe the fundamentals of AIOps

Module	Detailed Contents	Hrs.	CO

			Mapping
01	**Introduction to Artificial Intelligence and Intelligent Agents** 1.1 Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally, Ethics in AI 1.2 Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents, Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agents. 1.3 Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent **Self-learning Topics:** History of AI, The present state of AI, PEAS Analysis	08	CO1
02	**Solving Problems by Searching** 2.1 Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems 2.2 Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search 2.3 Informed Search: Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search, 2.4 Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning **Self-Learning Topic:** Optimization: Genetic Algorithm	10	CO2
03	**Machine Learning (ML) and Deep Learning (DL)** 3.1 Introduction to Machine Learning, Supervised Learning: Linear / Logistic Regression, Decision Trees, Unsupervised Learning: Clustering (K-Means), Dimensionality Reduction (PCA), Reinforcement Learning: Agents, rewards, and environment modelling. 3.2 What is Deep Learning? Historical context, Machine Learning vs. Deep Learning, Evolution of Neural Networks, Biological Neuron, McCulloch-Pitts Model, Perceptron, Designing a simple network, non-separable patterns, Perceptron model with Bias. Limitations of Perceptron	07	CO3
04	**Artificial Neural Networks** 4.1 Multi-layer Perceptrons (MLP), Feedforward Neural Networks, Activation functions, Loss functions, Learning parameters with Error back propagation algorithm, 4.2 Gradient Descent, Variants of Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	08	CO4

	4.3 Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Debugging and tuning deep models		
05	**Benefits and Application of AI** 5.1 Benefits of AI 5.2 AI applications in Healthcare, Retail, Banking, education and Manufacturing . **Self-Learning Topic:** Case study on AI applications in Robotics, Business	**04**	**CO5**
06	**Introduction to Advanced AI** 6.1 Introduction to Gen AI, Agentic AI, Explainable AI and Responsible AI 6.2 AIOps: Key Aspects of AIOps, Elements of AIOps, Three-phased AIOps approach, benefits and use cases.	**05**	**CO6**

Textbooks:	
1	Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2	Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
4	Ethem Alpaydın, —Introduction to Machine Learning‖, MIT Press McGraw-Hill Higher Education
5	Peter Flach, —Machine Learning‖, Cambridge University Press
6	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
7	JM Zurada —Introduction to Artificial Neural Systems‖, Jaico Publishing House
8	Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 1st Ed. (2016), ISBN: 978-0262035613
References:	
1	D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
2	Saroj Kaushik “Artificial Intelligence”, Cengage Learning.
3	Davis E. Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
4	Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley, Third Edition.
5	N. P. Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.
6	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall

	International, Inc

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2	https://www.classcentral.com/course/independent-elements-of-ai-12469
3	https://tinyurl.com/ai-for-everyone
4	https://www.deeplearningbook.org/
5	https://www.cse.iitm.ac.in/~miteshk/CS6910.html

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: 05 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 05 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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPCC 502	Machine Learning	20	20	60	1	2	100	

Prerequisite: Linear Algebra, Probability & Statistics, Calculus, Programming (Python or R recommended)	
Course Objectives: The course aims to	
1	Learn the fundamental concepts and Workflow of Machine Learning.
2	Gain an in-depth understanding of supervised learning methods for Regression and performance evaluation metrics.
3	Gain an in-depth understanding of supervised learning methods for Classification and performance evaluation metrics.
4	Ability to apply unsupervised learning to discover patterns or structures in data
5	Acquire knowledge of ensemble methods: combine multiple models to produce a single, stronger predictor
6	Create ML pipeline for a real world problem
Course Outcomes: Learners will be able to	
1	Gain basic knowledge of the fundamental concepts and Workflow of Machine Learning.
2	Implement Regression methods and apply to real world data along with evaluating model performance using appropriate metrics.
3	Implement Classification methods and apply to real world data along with evaluating model performance using appropriate metrics.
4	Apply unsupervised learning to discover patterns or structures in data
5	Gain knowledge of ensemble methods: combine multiple models to produce a single, stronger predictor

6	Apply MLOps principles and tools for automating pipelines, managing ML models, version control, and monitoring ML models in production

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction To Machine Learning** 1.1 Basic definitions, types of learning (Supervised, Unsupervised, Reinforcement), 1.2 Key Concepts: Regression, Classification Clustering and Prediction, Training, Testing and validation dataset, cross-validation methods (leave-one-out (LOO), k-folds), bias-variance trade-off, overfitting and underfitting of model 1.3 Machine Learning Pipeline (data preprocessing, feature engineering, model training, evaluation, deployment), Applications of Machine Learning. **Self-learning Topics**: Eigenvalues and Eigenvectors, Orthogonal Projections, Diagonalization, SVD and its applications	05	CO1
02	**Supervised Learning – Regression** 2.1 Linear Regression, Multiple Linear Regression. 2.2 Logistic Regression, Support Vector Machine (SVM) 2.3 Regularization Techniques: Ridge and Lasso regression, Model evaluation metrics: R^2, MSE, RMSE, **Self-Learning Topic:** Platforms such as Anaconda, COLAB, Study of Machine Learning Libraries and tools	04	CO2
03	**Supervised Learning –Classification** 3.1 Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART) 3.2 Naïve Bayes, k-Nearest Neighbors (kNN). 3.3 Support Vector Machines (SVMs), Hard and Soft margin in SVM, Hinge Loss function of SVM, Kernel SVM and its types, Kernel trick 3.4 Model evaluation metrics: Accuracy, Precision, Recall, F1-score, ROC-AUC **Self-Learning Topic:** Platforms such as Anaconda, COLAB, Study of Machine Learning Libraries and tools	10	CO3
04	**Unsupervised Learning**		

	4.1 Clustering: k-Means, Hierarchical Clustering, DBSCAN. 4.2 Curse of Dimensionality, Feature Selection and Feature Extraction, Dimensionality Reduction Techniques: Principal Component Analysis, 4.3 Association Rule Learning: Apriori, FP-Growth 4.4 Anomaly Detection	**08**	**CO4**
	Self-Learning Topic: t-distributed Stochastic Neighbour Embedding (t-SNE), Linear Discriminant Analysis, Gaussian Mixture Models (GMM) and Expectation-Maximization (EM) algorithm.		
05	**Ensemble Methods**	**08**	**CO5**
	5.1 Ensemble intuition; variance reduction; bootstrap sampling; Bagging; Random Forests 5.2 AdaBoost algorithm, weight updates, perceiving boosting as additive modeling; Gradient Boosting Machines (GBM) intuition; loss functions and stagewise additive modeling; introduction to XGBoost/LightGBM 5.3 Stacking/blending; cross-validated meta-learners; calibration; feature engineering for ensembles; hyperparameter tuning strategies; computational considerations		
	Self-Learning Topic: Evaluation and Applications of Ensemble Models		
06	**MLOps**	**07**	**CO6**
	6.1 Introduction to MLOps, Traditional ML lifecycle vs. MLOps lifecycle, DevOps and MLOps, Overview of CI/CD for ML 6.2 Data Engineering for MLOps- Data collection, validation, and versioning, pipelines, Model Development and Experiment Tracking, Model Packaging and Environment Management, Model Deployment 6.3 Continuous Integration & Continuous Delivery (CI/CD) for ML, Monitoring and Maintenance, Overview of MLOps Tools & Platforms		
	Self-Learning Topic: Build a CI/CD pipeline that trains and deploys a simple ML model		

Textbooks:	
1	Machine Learning – Tom M. Mitchell, McGraw-Hill, 1st Ed. (1997), ISBN: 978-0070428072
2	Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer, 1st Ed. (2006), ISBN: 978-0387310732
3	Understanding Machine Learning: From Theory to Algorithms – Shai Shalev-Shwartz & Shai Ben-David, Cambridge University Press, 1st Ed. (2014), ISBN: 978-1107057135.

4	Practical MLOps: Operationalizing Machine Learning Models" by Noah Gift and Alfredo Deza
5	Building Machine Learning Powered Applications: Going from Idea to Product - Emmanuel Ameisen - O'Reilly publication
References:	
1	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron, O'Reilly Media, 3rd Ed. (2022), ISBN: 978-1098125974
2	The Elements of Statistical Learning – Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2nd Ed. (2009), ISBN: 978-0387848570
3	Deep Learning – Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 1st Ed. (2016), ISBN: 978-0262035613
4	Mathematics for Machine Learning – Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 1st Ed. (2020), ISBN: 978-1108455145
5	Machine Learning Yearning – Andrew Ng, Self-Published, 1st Ed. (2018) (Available for free online)
6	Introducing MLOps - Mark Treveil & Alok Shukla
Web Links:	
1	NPTEL
2	https://www.learndatasci.com/out/coursera-machine-learning/
3	https://www.learndatasci.com/out/google-machine-learning-crash-course/
4	Introduction to Machine Learning: Coursera - Machine Learning by Andrew Ng
5	Mathematical Foundations for ML: MIT OpenCourseWare - Linear Algebra
6	Gradient Descent & Linear Models: Stanford CS229 - Machine Learning
7	Ensemble Learning: Towards Data Science - Ensemble Methods
8	Neural Networks & Deep Learning: Deep Learning Specialization by Andrew Ng
9	Dimensionality Reduction: Scikit-learn - PCA & Feature Selection

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

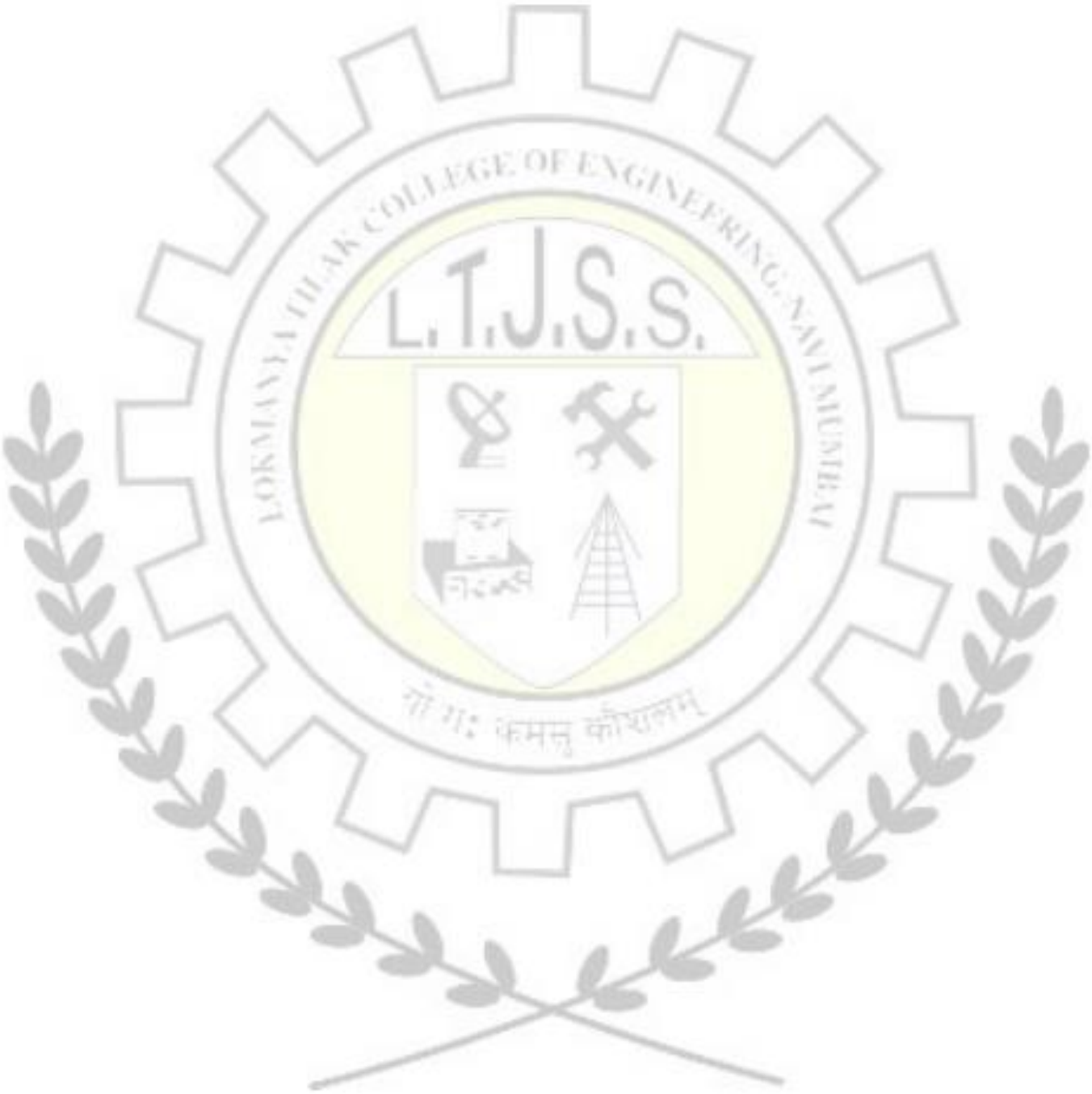
B. Continuous Internal Evaluation (20 Marks)

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPCC 503	Statistical Data Analysis and Visualization	20	20	60	1	2	100	

Prerequisite: Basic knowledge of Probability (Sample space, Events), Basic programming skills (preferably Python or R).	
Course Objectives: The course aims to	
1	To apply descriptive statistics and perform Exploratory Data Analysis (EDA) for raw data summarization and quality assessment.
2	To conduct rigorous confidence interval estimation and statistical hypothesis testing.
3	To derive meaningful business and research insights.
4	To select and design appropriate static and multivariate chart types based on data characteristics and analytical goals.
5	To formulate compelling data narratives using visual and statistical evidence for both technical and non-technical stakeholders.
6	To execute a complete statistical project and construct interactive, professional-grade data dashboards.
Course Outcomes: Learners will be able to	
1	Understand the data analytic life-cycle and analyze raw data
2	Apply the principles of probability distributions, the Central Limit Theorem (CLT), and sampling techniques
3	Evaluate the assumptions and performance of statistical models
4	Analyze the principles of effective data visualization and select appropriate chart types (static and multivariate)

5	Formulate a compelling data narrative using visual and statistical evidence
6	Construct a complete statistical project by integrating programming tools (Python) for analysis and BI tools (Tableau/Power BI)

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Data Analytics and Descriptive Statistics** 1.1 The Data Analytics Lifecycle: Overview, Phases. Role of Statistics in Data Science. 1.2 Types of Data: Data types, Measures of Central Tendency (Mean, Median, Mode) and Dispersion (Variance, Standard Deviation, Quartiles, IQR). 1.3 Probability Basics in Statistics: Conditional probability, Bayes' Theorem. Measures of correlation and covariance. **Self-learning Topics**: Probability Distributions Visualization, Skewness and Kurtosis, Data Analytics Roles	05	CO1
02	**Data Preparation and Exploratory Data Analysis (EDA)** 2.1 Introduction of ETL & ELT techniques. 2.2 Data Pre-processing: Data cleaning, Handling missing values (Imputation techniques), Outlier detection, Data transformation (Log transformation, square root). 2.2 Data Transformation and Feature Engineering: Normalization and Standardization (z-score), Encoding categorical data (One-hot, Label encoding), Principal Component Analysis (PCA) Implementation **Self-Learning Topic:** Advanced Imputation Techniques, Feature Interaction and Creation	07	CO2
03	**Statistical Distributions and Inferential Statistics** 3.1 Sampling and Estimation: Population vs. Sample, Sampling methods, Point and Interval Estimation, Standard Error, Confidence Intervals. 3.2 Probability Distributions: Discrete Distributions (Binomial, Poisson) and Continuous Distributions (Normal, Gaussian Distribution). Central Limit Theorem (CLT) and its significance in data analysis. 3.3 Hypothesis Testing: Introduction, Null and Alternative Hypothesis, Type I and Type II errors, p-value, One-sample and Two-sample t-tests, Chi-square test (Conceptual overview). **Self-Learning Topic:** Advanced Hypothesis Tests, Non-Parametric Tests, P-hacking and Replication Crisis	09	CO3

04	**ANOVA: Analysis of Variance** 4.1 The One-Way Layout, Normal Theory, the F Test, The Problem of Multiple Comparisons, A Nonparametric method-The Kruskal-Wallis Test, The Two-Way Layout, Additive Parametrization, Normal Theory for the Two-Way Layout, Randomized Block Designs, A Nonparametric Method-Friedman's Test. 4.2 Data Science and p-Value, t-Tests, Multiple Testing Degrees of Freedom, ANOVA, F-Statistic, Two-Way ANOVA, Fisher's Exact Test, Relevance for Data Science, Multi-Arm Bandit Algorithm, Power and Sample Size, Sample Size. **Self-Learning Topic:** Hypothesis Testing using any Statistical tool	**08**	**CO4**
05	**Principles and Tools for Data Visualization** 5.1 Fundamentals of Visualization: Importance of visualization, Principles of effective visualization, Visualizing single and multiple variables. 5.2 Basic Visualization Techniques: Bar Charts, Histograms, Box Plots, Scatter Plots, Line Graphs, Pie Charts, Heatmaps. Choosing the right chart type. 5.3 Visualization with Python Libraries: Introduction to Matplotlib and Seaborn/Plotly. Creating static and basic interactive plots for statistical insights. **Self-Learning Topic:** Choosing Color Palettes, Advanced Matplotlib/Seaborn Customization	**07**	**CO5**
06	**Business Intelligence** 6.1 Advanced and Multivariate Visualization: Visualizing large-scale and multidimensional data, Pair plots, Geographic Information System (GIS) visualizations (Introduction). 6.2 Interactive Dashboards: Introduction to Business Intelligence (BI) tools (e.g., Tableau, Power BI, Looker Studio - Conceptual/Demonstration only), Creating and sharing interactive dashboards and dynamic reports. 6.3 Case Study: Creating a compelling narrative with data, 6.4 Do's and Don'ts of visual presentation, Presenting and communicating statistical findings and insights to stakeholders. **Self-Learning Topic:** Interactive Visualization with Plotly/Dash, Introduction to Geospatial Data Visualization, Stakeholder Communication Strategies	**06**	**CO6**

Text Books:

1. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python by Peter Bruce, Andrew Bruce, and Peter Gedeck. O'Reilly Media.
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services, Wiley Publication.
3. The Visual Display of Quantitative Information by Edward R. Tufte. Graphics Press.

References:

1. Naked Statistics: Stripping the Dread from the Data by Charles Wheelan. W. W. Norton & Company.
2. Data Analytics using Python by Bharati Motwani. Wiley Publications.
3. Visual Analytics Using Tableau: Structured approach for turning raw data to powerful insights by Neha Singh Rajput and Sulabh Bhatt.
4. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber, and Jian Pei. Elsevier.

Useful Links:

1. https://math.mit.edu/~gs/linearalgebra/
2. https://onlinecourses.nptel.ac.in/noc24_ma30/preview
3. https://onlinecourses.nptel.ac.in/noc25_cs20/preview
4. https://www.classcentral.com/course/swayam-introduction-to-data-visualization-452115
5. https://www.coursera.org/learn/probability-statistics
6. https://ocw.mit.edu/courses/18-06sc-linear-algebra-fall-2011/
7. Pandas NumPy tutorial for data analysis, Scikit-learn Linear and Logistic Regression tutorial, Tableau Public tutorial for beginners OR Microsoft Power BI tutorial for data visualization

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 5011	Computer Network & Security	20	20	60	1	2	100	

Prerequisite: Basic Mathematics, Modular Arithmetic	
Course Objectives: The course aims to	
1	To introduce concepts of computer networks & security and working of various layers of OSI.
2	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
3	To assess the strengths and weaknesses of various routing algorithms.
4	To understand various transport layer and application layer protocols
5	To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
6	The concepts of cryptographic utilities and authentication mechanisms to design secure applications
Course Outcomes: Learners will be able to	
1	Demonstrate the concepts of data communication at physical layer and compare ISO – OSI model with TCP/IP model and Identify information security goals,.
2	Explore different design issues at data link layer.
3	Design the network using IP addressing and sub netting / super netting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Understand, compare and apply different encryption and decryption techniques and Apply different digital signature algorithms to achieve authentication and create secure applications
6	Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Networking**	06	CO1
	1.1 Introduction to computer network, Network Devices, Network. topology, Switching: Circuit-Switched Networks, Packet Switching, Network Types: LAN, MAN, WAN 1.2 Reference models: Layer details of OSI, TCP/IP models. Difference between OSI and TCP/IP. 1.3 Overview of Network Security: Elements of Network Security, Classification of Network Attacks, Security Methods		
	Self-learning Topics: Basics of computer networking, Encapsulation and decapsulation, Analog and Digital communication		
02	**Physical and Data Link Layer**	08	CO2
	2.1 Physical Layer: Communication mechanisms and electro-magnetic Spectrum, Guided Transmission Media: Twisted pair, Coaxial, Fiberoptics 2.2 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 2.3 Channel Allocation problem, Multiple access Protocol (ALOHA, CSMA/CD).		
	Self-Learning Topic: Concept of signals, transmission, and bit synchronization, frames, nodes, and links		
03	**Network Layer**	07	CO3
	3.1 Network Layer: Communication Primitives, IPv4 Addressing (classful and classless), Subnetting, IPv4 Protocol, Network Address Translation (NAT), IPv6 addressing, IPv4 vs IPv6 addressing, Routed vs Routing protocols, 3.2 Classification of Routing algorithms, Shortest Path algorithms (Dijkstra's), Link state routing, Distance Vector Routing		
	Self-Learning Topic: Concept of Congestion control and Quality of Service (QoS), static and dynamic routing in Cisco Packet Tracer		
04	**Transport Layer and Application Layer**	06	CO4
	4.1 Transport Layer: Service primitives, Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers, TCP Flow control (sliding Window) 4.2 Application Layer: HTTP, SMTP, Telnet, FTP, DHCP, DNS and Types of Name Server		
	Self-Learning Topic: Use Cisco Packet Tracer or NS3 to simulate TCP and UDP communicatio**n**		

05	**Cryptography, Authentication and Digital Signature scheme** 5.1 Symmetric-Key Cryptography: Data Encryption Standard (DES), Advanced Encryption Standard (AES) and Public-Key, Cryptography: RSA Algorithm, Key management – Diffie Hellman Key exchange 5.2 Authentication: Hash Function, Secure Hash Algorithm (SHA), n Digital Certificate: X.509 5.3 Digital signature and authentication protocols: Needham Schroeder Authentication protocol, Digital Signature Schemes –RSA **Self-Learning Topic:** Number Theory: Greatest Common Divisor, Extended Euclidean Algorithm, Linear Congruence	**08**	**CO5**
06	**IP Security and Web security** 6.1 IP Security: IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management, Recommended Reading and Web Site, Key Terms. 6.2 Web security: Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Web Browser Attacks, Web Bugs, Click jacking, Cross Site Request Forgery, Session Hijacking and Management, Phishing Technique, DNS Attack, Secure Electronic Transaction, Email Attacks, Firewalls. **Self-Learning Topic:** Operating System Security, Database Security.	**07**	**CO6**

Text Books:

1. A.S. Tanenbaum, Computer Networks,4 th edition Pearson Education
2. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach,Mc Graw Hill education.
3. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
4. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education.

Reference Books:

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
4. Web Application Hackers Handbook by Wiley.
5. Computer Security, Dieter Gollman, Third Edition, Wiley

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 5012	Theory of Computation	20	20	60	1	2	100	

Prerequisite: Discrete Mathematics and Graph Theory	
Course Objectives: The course aims to	
1	Acquire conceptual understanding of fundamentals of grammar and languages.
2	Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata., syntax, semantics, and pragmatics. morphology, syntax, semantics, and pragmatics.
3	Develop understanding different types of Turing machines and applications.
4	Understand the concept of Undecidability.
Course Outcomes: Learners will be able to	
1	Understand concepts of Theory of computation, difference and equivalence of DFA and NFA, languages described by finite automata and regular expressions
2	Design Context free grammar, pushdown automata to recognize the language.
3	Develop an understanding of computation through Turing Machine.
4	Acquire fundamental understanding of decidability and undecidability.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Basic Concepts and Finite Automata**	12	CO1
	1.1 Introduction of Automata Theory, Finite Automata as a language acceptor and translator		
	1.2 Types of Finite Automata: Non Deterministic Finite Automata (NDFA), Deterministic finite automata (DFA), Equivalence between NFA with and without ε- transitions, conversion of NDFA to DFA, minimization of automata machines,Meaning of union, intersection,		

	concatenation and closure, 2 way DFA		
	1.3 FSM: Moore machines and mealy machines, composite machine, Conversion from Mealy to Moore and vice versa.		
	Self-learning Topics: Alphabets, Strings		
02	**Regular Expression and Languages**	**06**	**CO1**
	2.1 Regular Expression (RE), Arden's theorem, Equivalence of RE and FA, Arden's Theorem 2.2 Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs		
	Self-learning Topics: RE Applications		
03	**Grammars**	**08**	**CO2**
	3.1 Grammars: Types of grammar, context sensitive grammar, and context free grammar, regular grammar 3.2 Derivation trees, Leftmost and Rightmost derivations, ambiguity in grammar, simplification of context free grammar, conversion of grammar to automata machine and vice versa 3.3 Chomsky hierarchy of grammar, killing null and unit productions Chomsky normal form		
	Self-Learning Topic: Greibach normal form		
04	**Push down Automata (PDA)**	**06**	**CO2**
	4.1 Push down Automata: example of PDA 4.2 Deterministic and non-deterministic PDA, conversion of PDA into context free grammar and vice versa 4.3 CFG equivalent to PDA		
	Self-Learning Topic: Petrinet model		
05	**Turing Machine (TM)**	**06**	**CO3**
	5.1 Turing Machine: Techniques for construction, Design of TM as generator, decider and acceptor, Universal Turing machine Multitape, multihead and multidimensional Turing machine.		
	Self-Learning Topic: Applications and limitations of TM		
06	**Undecidability**	**04**	**CO4**
	6.1 Decidability and Undecidability, Recursive and Recursively Enumerable Languages, decidable languages, undecidable languages, 6.2 Halting problem, Rice's Theorem		

	Self-Learning Topic: Post Correspondence Problem		

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", 4th Edition
2. Kavi Mahesh, "Theory of Computation: A Problem Solving Approach", Kindle Edition, Wiley-India, 2011 applications: from theory to practice, IBM Press, 2013.

Useful Links:

http://www.jflap.org/
https://nptel.ac.in/courses/106/104/106104028/
https://nptel.ac.in/courses/106/104/106104148/

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

1. Quiz/Presentation/ Open Book Test: 5 Marks
2. Assignments(Best 5 out of 6): 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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 5013	Nature Inspired Optimization Algorithm	20	20	60	1	2	100	

Prerequisite: Optimization Algorithms	
Course Objectives: The course aims to	
1	Familiar with Genetic algorithm and its applications.
2	Compare different Ant Colony Optimization algorithmic models.
3	Compare different Artificial Bee Colony Optimization algorithmic models.
4	Illustrate Particle swam optimization algorithm with an example.
5	Knowledge on significance of intelligence , genetic Ant Colony algorithm.
6	Knowledge on Cuckoo Search and Firefly Algorithm.
Course Outcomes: Learners will be able to	
1	Identify the need of computational complexity, evolutionary, and approximate algorithms
2	Understand nature inspired algorithms, its strength, weakness, and suitability
3	Apply nature-inspired algorithms to design, learn and optimize problem
4	Evaluate performance of Nature inspired algorithm in context of problem solving in optimized manner
5	Create a real environment effective artificial system with the use of properties exhibited from nature.
6	Natural Design Considerations in Natural applications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Nature Inspired Computation Fundamental** 1.1 Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing 1.2 Computational Complexity, Optimization problems–single and multi-objective optimization. 1.3 Reductions, Approximation Algorithms vs. Heuristics, Newton Raphson Method 1.4 Characteristics of Natural Systems/Algorithms **Self-learning Topics**: Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation,	07	CO1
02	**Empirical and Evolutionary Algorithms** 2.1 Empirical Algorithms, Empirical hardness, NP- Hardness 2.2 Evolutionary Algorithms EA Theory, Swarm and evolutionary algorithm 2.3 optimization Fitness landscape Analysis **Self-Learning Topic:** Evolutionary models and techniques.	05	CO2
03	**Evolutionary Algorithms** 3.1 Genetic Algorithm, GA Encoding Techniques, Selection techniques, 3.2 Variation (Crossover and Mutation) Techniques, 3.3 Genetic Programming Differential Evolution Algorithm, 3.4 sample problems, DE-Crossover and Mutation techniques **Self-Learning Topic:** Mathematical foundation Markov process, applications of genetic algorithms	10	CO3
04	**Swarm Intelligence** 4.1 Particle Swarm Optimization Sample Problems, Binary PSO, variable length PSO 4.2 Ant Colony Optimization and real-life case study solutions, Artificial Bee Colony algorithm, multi-dimensional Bee colony algorithms 4.3 Cuckoo Search and its applications, Firefly Algorithm. 4.4 Optimization for the traveling salesman problem.	10	CO4

	Self-Learning Topic: applications of PSO, case studies applications of bee algorithms, hybrid ant system, Bat algorithm.		
05	**Modeling and problem solving** 5.1 Artificial Neural network, Artificial Immune System 5.2 Self-organizing Maps, Pattern Recognition and Binding, Social spider algorithm. 5.3 Forest's Algorithm, Flower pollination algorithm, case studies **Self-Learning Topic:** Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm**,**	**05**	**CO5**
06	**Biologically Inspired Computing Hardware** 6.1 Overview of Memristors and neuromorphic computing, 6.2.DNA computing and molecular algorithms 6.3 Quantum-inspired computing. **Self-Learning Topics:** Nature-Inspired and Innovative Computing	**05**	**CO6**

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Evolutionary Optimization Algorithms, D. Simon (2013), Wiley.
3. Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, D.Floreano and C. Mattiussi (2008), MIT Press.
4. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
5. N.P.Padhy,—Artificial Intelligence and Intelligent Systems‖, Oxford University Press.Leandro Nunes de Castro.
6. "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007

References:

1. Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, L. N. de Castro (2006), CRC Press.
2. Marco Dorrigo, Thomas Stutzle,” Ant Colony Optimization”, PHI,2005
3. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
4. Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press, 2008

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
CEMDM 501	Database Management System	20	20	60	1	2	100	

Course Objectives: The course aims to	
1	Learn and practice data modelling using the entity-relationship and developing database designs.
2	Implement the use of Structured Query Language (SQL) and learn SQL syntax.
3	Illustrate the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4	Analyse the concept of database security and privacy
Course Outcomes: Learners will be able to	
1	Describe the fundamentals of database systems
2	Implement the different data models and design issues in 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		
	Data Models		

02	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	3	**CO2**
03	**Database Design, ER-Diagram and Unified Modelling Language** Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	10	**CO3**
04	**Relational Algebra and Calculus** Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	10	**CO4**
05	**Constraints, Views and SQL** What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	10	**CO5**
06	**Transaction management and Concurrency control** Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy: Issues, Access Control based on grant and revoke privileges	05	**CO6**
	Total	**42**	

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ETMDM 501	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**	04	CO1
	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.		
02	**Information Theory and Source Coding** Measure of Information, Entropy, Information rate, Channel capacity, Shannon-Hartley Capacity Theorem and its implications, Source coding: Huffman coding, Code Efficiency & Redundancy **Self-Learning Topic:** Study how source coding reduces data size in practical file compression and transmission.	**06**	**CO2**
03	**Channel Coding** Need for channel encoding, Concept of Error detection and correction, Forward Error correction Linear block codes: Hamming Distance, Hamming Weight, Systematic codes, Syndrome, Cyclic codes: Generator polynomial for Cyclic codes, Systematic cyclic codes Convolution codes: Convolution encoder, Impulse response of encoder	**06**	**CO3**
04	**Digital Transmission Fundamentals & Modulation Strategies** Digital Transmission Fundamentals: Baseband and Passband Transmission, Line codes and their desirable properties, PSD of digital data, Baseband PAM transmission: Concept of Inter symbol interference (ISI), Eye diagram Types of digital modulation techniques and their advantages; concept of coherent vs. non-coherent detection Shift-keying techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Differential Phase Shift Keying (DPSK), Quadrature Phase Shift Keying (QPSK): Types, Quadrature Amplitude Modulation (QAM): block diagrams of ransmitter/receiver, working principle, key waveforms & constellation diagrams **Self-Learning Topic**: M-ary encoding: M-ary FSK and M-ary PSK	**12**	**CO4**
05	**Fundamentals of Sensor Technology** Introduction to Sensors, Classification, Selection, and Characteristics of Sensors: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy Primary Sensing Elements and Signal Conditioning, Principles, Construction, and Applications of Common Sensors (potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor).	**06**	**CO5**
06	**Transducer and Microsensor Technologies** Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: capacitor microphone, capacitive pressure sensor, proximity sensor Micro Sensors and Micro Actuators: Principles, Types and examples	**08**	**CO6**

	Self-Learning Topic: Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors		

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 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**	**05**	**CO1**
	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.		
02	**Selection of Sensors & Actuators**	**07**	**CO2**
	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		
	Self-Learning Topic: Examples of sensors used in household appliances (fridge, washing machine, AC), Comparison of DC motor vs Stepper motor in simple applications, Selection of an actuator for a small robotic arm		
03	**Data Acquisition, Signal Conditioning & Microcontroller System Theory**	**07**	**CO3**
	3.1. Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Converter), Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Converter), R-2R circuit and DAC resolution 3.2. Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases		
	Self-Learning Topic: Use of low-pass filter in removing noise from a sensor signal, Applications of band-pass filters		
04	**Design of Pneumatic & Hydraulic Circuits**	**08**	**CO4**
	4.1.Design of Pneumatic Sequencing Circuits using the Cascade method and the shift register method (up to 2 cylinders) 4.2.Basic Hydraulic Circuits: Meter in, meter out, and bleed off circuits; Intensifier circuits, Regenerative Circuit, Counterbalance valve circuit and sequencing circuits.		
	Self-Learning Topic: Identification of hydraulic circuits used in industry (press machines, lifting systems), Simple case study of meter-in vs meter-out control in hydraulic actuators, Safety precautions in handling hydraulic and pneumatic systems		
05	**Design of Electro-pneumatic Circuits**	**08**	**CO5**
	5.1. Electro-pneumatic Circuits Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves, with and without grouping.		

	5.2. PLC Discrete Control Systems Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.		
	Self-Learning Topic: Identification of electro-pneumatic components used in industrial machines, Real-life examples of pneumatic systems in automation, Safety rules and precautions when working with pneumatic circuits		
06	**Reliability, communication, and Case studies**	**07**	**CO6**
	6.1. Reliability, maintainability, safety, and fault diagnosis in mechatronic systems 6.2. Communication Protocols (overview only), CAN, UART, SPI, I2C (basics only) 6.3. Case Studies: Automotive ABS, CNC feed drive system, Pick & place robot, Smart manufacturing cell		

Text Books:

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

References:

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

NPTEL/SWAYAM courses:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

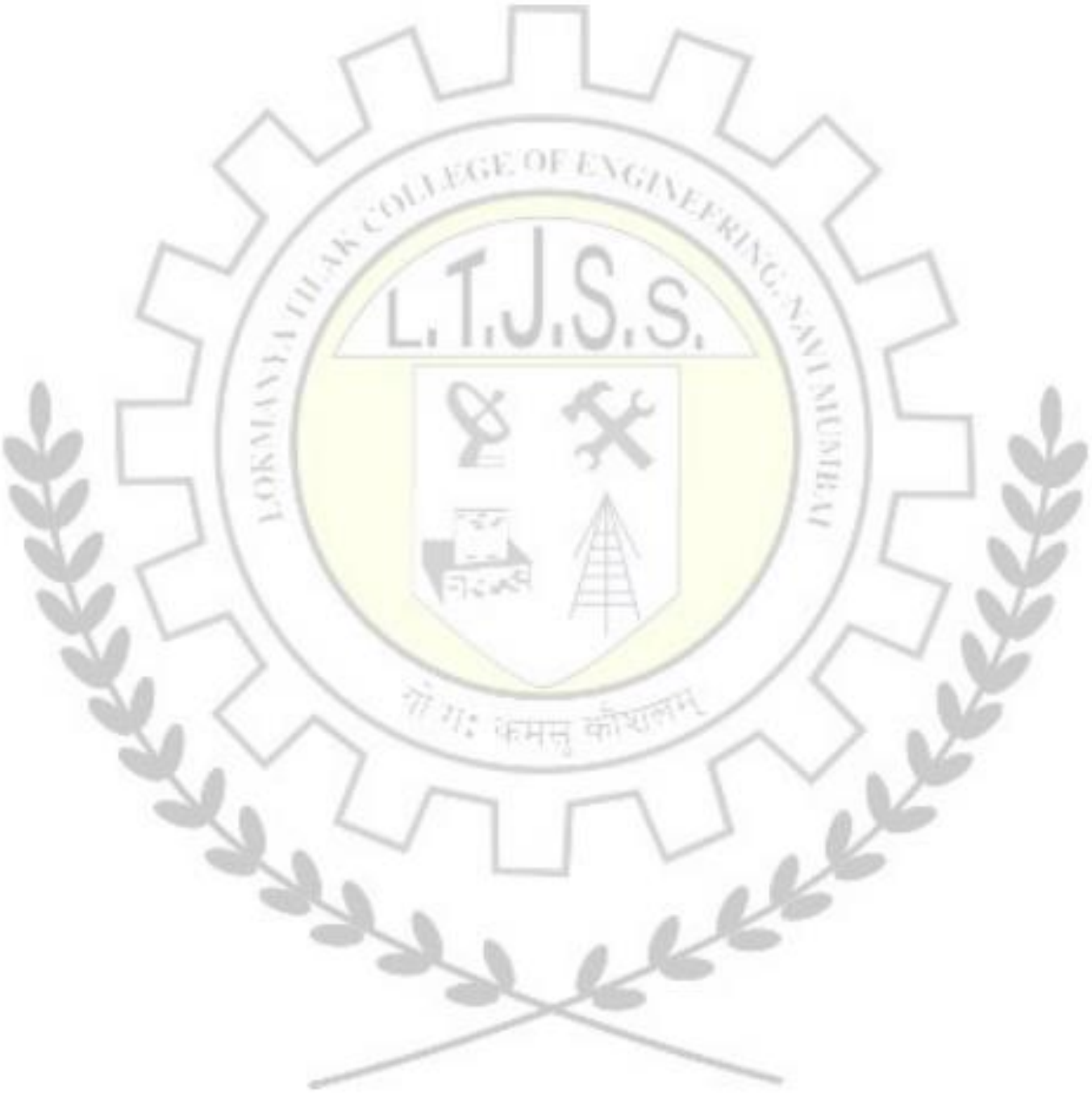
Mid semester examination will be based on 40 % to 50% of the syllabus.

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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



Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ITMD501	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**	7	CO1
	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		
02	**Thermal Sensors**	8	CO2

	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**.**		
	Self-Learning Topic: Resistive potentiometer, strain gauge, quartz crystal thermoelectric sensor.		
03	**Radiation sensor**	**8**	**CO3**
	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.		
04	**Smart Sensors**	**8**	**CO4**
	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		
05	**Recent Trend in sensor technology**	**8**	**CO5**
	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		
06	**Sensors-Their Applications**	**6**	**CO6**
	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		

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						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 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.	09	**CO2**

	Self-Learning Topic: Hydrology		
03	**Nuclear Energy** Nuclear fission, fusion, components & layout of Nuclear Power plants, Site Selection. Safety & waste disposal **Self-Learning Topic: Nuclear Materials**	05	**CO3**
04	**Module Title:** Solar Energy Solar Radiation, Sun Earth Angle, Solar Measurement Devices, Solar Energy Collectors. Application of Solar Energy	07	**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. **Wind Energy**	07	**CO5**
06	**Other Renewable Energy Sources.** Mini & Micro Hydro Electric Plants, Application & Site Selection. Hybrid Energy, Economic Environmental & Regulatory Aspects of Renewable Sources. **Self-Learning Topic:** Hydrology	06	**CO6**

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

1. Quiz/Open book test/Presentation: 15 Marks
2. Regularity and attendance: 05 Marks

End Semester Examination (60 Marks)

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

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

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

Module	Detailed Contents	Hrs.	CO Mapping
01	**Stepper Motors:**	07	CO1
	1.1 Construction and working principles. 1.2 Types: Variable Reluctance, Permanent Magnet, and Hybrid Stepper		

	Motors. 1.3 Torque–angle characteristics, static and dynamic performance 1.4 Drive and control circuits (unipolar/bipolar, open-loop and closed-loop control) 1.5 Microcontroller or Arduino-based stepper control 1.6 Applications**:** CNC machines, robotics and printers		
	Self-Learning Topic: Application in positioning system		
02	**Switched Reluctance Motors (SRM)**	**07**	**CO2**
	2.1 Construction and operating principles 2.2 Torque production and control methods 2.3 Converter topologies for SRM drives 2.4Sensor and sensorless control techniques 2.5 Design and performance considerations 2.6 Applications: Electric vehicles and renewable energy systems		
	Self-Learning Topic: Applications in industrial drives		
03	**Brush less DC Motors (BLDC)**	**07**	**CO3**
	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.		
04	**Permanent Magnet Synchronous Motors (PMSM)**	**07**	**CO4**
	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.		
05	**Introduction to smart grid :**	**07**	**CO5**
	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.		

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 Yezdani, and Reza Iravani, Voltage Source Converters in Power Systems: Modeling, Control and Applications, John Wiley Publications, 2010.
5. Dorin Neacsu, Power Switching Converters: Medium and High Power, CRC Press, 2006.
6. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012.
7. IEEE standards ―IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems IEEE standards 2003.
8. IEEE standards ―IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System.
9. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS Microgrid Concept‘2002.
10. 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						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2* +2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
DSVSEC 501	UI & UX Design*	-	50	25	-	-	75	

Prerequisite: HTML, CSS, Javascript		
* e-learning		
Module	**Detailed Contents**	**CO Mapping**
01	**React Fundamentals**	CO1
	Installation, installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices. React vs Angular vs Vue	
02	**Advanced React:**	CO2
	Functional components- Refs, Use effects, Hooks, Flow architecture, Model-ViewController framework, Flux, Bundling the application. Web pack, React Native, React Router, developing app using React.	
03	**Node.js:**	CO3
	Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module, Node.js with Mongodb. Express: Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React. Node.js with Mongodb, Commercial deployment.	
04	**React Native:**	CO4
	UI Design & Core Concepts in React Native: Introduction to cross-platform apps (Native vs Hybrid vs Cross-platform),Overview of React Native, Development setup (Node.js, Expo CLI), Project structure, UI Design & Components: Core	

	components: View, Text, Image, Lists: ScrollView, FlatList, Styling using Flexbox & StyleSheet, Responsive mobile UI design, Interaction & Navigation: User input (TextInput, Buttons, basic forms), Event handling, Navigation:Stack Navigator, Tab Navigator.	
05	**Advanced React Native**	**CO5**
	Data, Advanced Features & Deployment: State & Data Handling, Props and State, Hooks: useState, useEffect, API Integration: Fetching data from REST APIs, Displaying JSON data in UI, Device Features: Camera or Location (basic implementation), Permissions handling, Testing & Deployment: Debugging basics, APK build process, App deployment overview	
06	**DevOps**	**CO6**
	Introduction to DevOps: - Understanding of the process to be followed during the development of an application; Evolution from Agile to DevOps, DevOps culture, principles, and benefits; DevOps lifecycle: Continuous Integration, Delivery, Deployment, and Monitoring, Containerization Basics - Docker introduction, images, containers, Docker Hub, working with Docker Containers.	

Prerequisite: HTML, CSS, Javascript & Bootstrap	
Course Objectives: The course aims to	
1	To understand the fundamentals of React including components, props, state, and lifecycle methods.
2	To develop single-page applications using React Router and modern UI design practices.
3	To build scalable backend applications using Node.js and Express.js with REST APIs.
4	To design and develop cross-platform mobile applications using React Native.
5	To integrate frontend, backend, and mobile applications with APIs and data storage mechanisms.
6	To apply DevOps practices including version control, CI/CD pipelines, containerization, and deployment.
Course Outcomes: Learners will be able to	
1	Develop responsive web pages using HTML5, CSS3, Javascript & Bootstrap
2	Build interactive front-end applications using React and React Router.
3	Develop server-side applications and REST APIs using Node.js and Express.js.
4	Integrate React front-end applications with Express back-end services.
5	Develop cross-platform mobile applications using React Native and its core features.
6	Apply Git, GitHub, CI/CD, Docker, and Kubernetes basics for DevOps practices.

Sr. No.	Suggested List of Experiments	CO Mapping
1	HTML: Elements, Attributes, Head, Body, Hyperlink, Formatting, Images, Tables, List, Frames, Forms, Multimedia.	CO1
2	CSS3: Syntax, Inclusion, Color, Background, Fonts, Tables, lists, CSS3 selectors, Pseudo classes, Pseudo elements.	CO1
3	Javascript: Variables, Operators, Conditions, Loops, Functions, Events, Classes and Objects, Error handling, Validations, Arrays, String, Date.	CO1
4	Bootstrap: BootstrapGrid system, Forms, Button, Navbar, Breadcrumb, Jumbotron	CO1
5	React: Installation and Configuration, JSX, Components, Props, State, Forms, Events, Routers, Refs, Keys, single-page application using React Router.	CO2
6	Node.Js: Installation and Configuration, Asynchronous programming, Callbacks, Event loops, Creating express app.	CO3
7	Create a simple HTTP server and perform file operations using Node.js.	CO3
8	Develop a REST API using Express.js with routing and middleware.	CO3
9	Implement authentication and session management in Express.	CO4
10	Integrate React frontend with Express backend.	CO4
11	Set up React Native environment and create a basic mobile application using core components, Design responsive layouts using Flexbox and implement user input handling, Implement navigation (Stack/Tab) and manage state using hooks.	CO5
12	Fetch and display API data, and implement local storage (AsyncStorage), Use device features (Camera/Location) and implement animations & gesture handling.	CO5
13	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.	CO6
14	To understand Version Control System / Source Code Management, install Git and create a GitHub account, creating and managing a local Git repository, connecting local repository to Github.	CO6
15	Implement version control using Git, create a CI/CD pipeline, and deploy a containerized application using Docker/Kubernetes basics.	CO6

Text Books:

1. "Web Technologies, Black Book", by Kogent Learning Solutions Inc..
2. React and React Native: A Complete Hands-on Guide to Modern Web and Mobile Development by Adam Boduch and Roy Derks.
3. "Learning React Native: Building Native Mobile Apps with JavaScript" by Bonnie Eisenman, O'Reilly publication.
4. "Web Development with Node and Express" by Ethan Brown, O'Reilly Media.

5. "The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win" – Gene Kim, Kevin Behr, George Spafford, IT Revolution Press, 2018
6. "React Native in Action" – Nader Dabit, Manning Publications, 2019.

References:

1. https://onlinecourses.nptel.ac.in/noc20_cs52/preview
2. https://onlinecourses.swayam2.ac.in/nou24_cs09/preview
3. https://onlinecourses.nptel.ac.in/noc21_ar05/preview
4. https://www.youtube.com/watch?v=2N-59wUIPVI

A. Continuous Internal Evaluation (50 Marks)

1. Lab Performance: 10
2. Quiz/Open book test/Presentation: 10
3. Regularity and attendance: 5
4. NPTEL Courses: 10
5. Mini Project: 15

B. Oral and Practical Examination (25 Marks)

Oral and Practical Examination will consist of 25 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
DSPCL501	Artificial Intelligence & Machine Learning Lab	-	25	25	-	-	50	

Prerequisite: Python or R Programming	
Course Objectives: The course aims to	
1	Design suitable Agent Architecture for a given real world AI problem.
2	Apply appropriate search techniques used in problem solving.
3	Introduce platforms and libraries such as Anaconda, COLAB suitable for Machine learning
4	Gain an in-depth understanding of supervised and unsupervised learning methods e.g. Regression, Classification, Clustering.
5	Acquire knowledge of ensemble methods.
6	Introduce the neural network and deep learning concept.
Course Outcomes: Learners will be able to	
1	Identify suitable Agent Architecture for a given real world AI problem.
2	Implement various search techniques for a Problem-Solving Agent.
3	Implement Machine learning problems on platforms like Anaconda, COLAB
4	Apply supervised and unsupervised learning methods for real world problems.
5	Ability to use ensemble methods to enhance the performance.
6	Implement neural network and deep learning based applications for real world problems.

Artificial Intelligence:		**CO Mapping**
1	Provide the PEAS description and TASK Environment for a given AI problem.	CO1

2	Implement Uniformed search techniques i.e. Breadth First Search and Depth First Search.	CO2
3	Implement Informed search techniques i.e. A* algorithm for 8 puzzle problem.	CO2
4	Implement any one of the Local Search techniques. E.g. Hill Climbing, Simulated Annealing, Genetic algorithm	CO2
5	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.	CO2
6	Introduction to platforms such as Anaconda, COLAB	CO3
7	Study of Machine Learning Libraries and tools (Python library, tensorflow, keras)	CO3
Machine Learning: Implementation of following algorithms for a given example data set (e.g Applications of following algorithms as a case study (E.g. Handwriting Recognition using MNIST data set, classification using IRIS data set, etc)		
1	Linear Regression	CO4
2	Logistic Regression.	CO4
3	Decision Tree	CO4
4	KNN/ Naïve Bayes	CO4
5	Support Vector Machines	CO4
6	K-means	CO4
7	PCA	CO4
8	Bagging	CO5
9	Boosting	CO5
10	Voting	CO5
11	McCulloch Pitts Model / Single Layer Perceptron Learning algorithm	CO6
12	Error Backpropagation Perceptron Training Algorithm	CO6

Links:

https://www.learndatasci.com/out/edx-columbia-machine-learning/

https://www.learndatasci.com/out/oreilly-hands-machine-learning-scikit-learn-keras-and-tensorflow-2nd-edition/

https://www.learndatasci.com/out/google-machine-learning-crash-course/

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. Capstone Project: 05 Marks

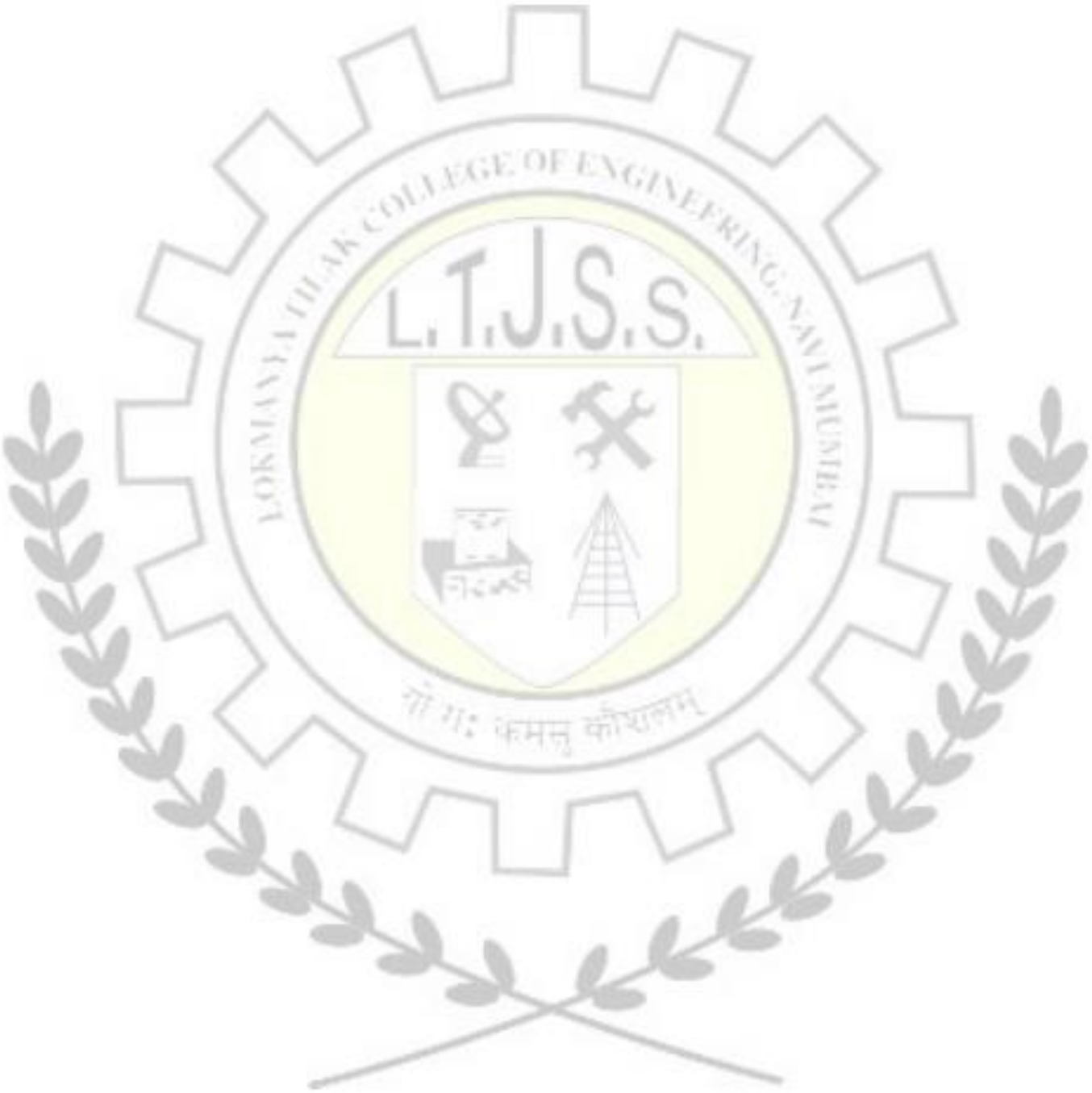
   End-to-end ML system:

Data ingestion → Model training → CI/CD → Deployment → Monitoring
Use real-world dataset (e.g., Kaggle)
Demonstrate automation and scalability

3. In-Semester Practical Exam during lab session: 05 Marks
4. Regularity and Attendance: 05 Marks

Oral & Practical Exam (25 Marks)

An Oral & Practical exam will be held based on the entire syllabus of **DSPCC501, DSPCC502**, **DSPCL501 & DSPCL502**.



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
DSPCL503	**Statistical Data Analysis and Visualization Lab**	-	25	25	-	-	50	

Prerequisite: Python or R Programming	
Course Objectives: The course aims	
1	To provide hands-on experience in exploring, analyzing and visualizing statistical data using modern BI tools.
2	To develop students' competency in building dashboards, performing statistical transformations, and interpreting insights for decision-making.
3	To enable understanding of tool-specific features (Power BI, Tableau, Looker Studio) and their application to real-world datasets for analytics.
Course Outcomes: Learners will be able to	
1	Import, preprocess and manage datasets for analysis in BI tools.
2	Apply statistical techniques (descriptive, inferential, regression) to cleaned data.
3	Build interactive dashboards and visualisations in Power BI, Tableau and Looker Studio for effective communication of insights.
4	Interpret results from statistical analyses and visualisations and make data-driven recommendations.
5	Compare and evaluate the features of different BI tools and select appropriate visualisations for given analytics problems.

Sr.No	Suggested List of Experiments	CO Mapping
1	Data Import and Pre-processing in Power BI	CO1
2	Data Cleaning: Missing Data and Outliers (Python)	CO2
3	Data Preparation and Feature Engineering (Python): Implement Standardization (z-score), Data Transformation (e.g., Log), and Categorical Encoding	CO2
4	Looking at the data: Data Summaries: Measures of Central Tendency,	CO2

	Measures of Dispersion, Measures of skewness and kurtosis	
5	Descriptive Statistics & Visualisation in Power BI Compute mean, median, mode, standard deviation; create histograms, box plots and summary dashboards in Power BI.	CO3
6	Dashboard design in Tableau for Business Use-Case: Design an interactive dashboard in Tableau combining multiple views, filters, tooltips, and storytelling.	CO3
7	Looker Studio – Data Source Connecting & Basic Reporting: Connect Google Sheets/BigQuery to Looker Studio; create basic report with charts and control filters.	CO3
8	Statistical Modelling (Regression) & Visualisation in Tableau: Fit a simple linear regression (or use built-in analytics) in Tableau; visualise regression line, residuals, and interpret output.	CO4
9	Statistical Hypothesis Testing & Visualisation: Perform hypothesis tests (t-test, chi-square) in any tool or via export + tool, visualise outcomes and interpret significance.	CO4
10	Comparative Analytics: Power BI vs Tableau vs Looker Studio: Given a dataset and analytics question, build comparable dashboards in all three tools and evaluate strengths/weaknesses.	CO3, CO5
11	Advanced Visualisations in Looker Studio – Maps, Geo Charts, Time Animations, Use Looker Studio to build geospatial visualisations and animated time-based visual trends.	CO3, CO5
12	Mini Project: Student-Defined Dataset & Tool Choice	CO1, CO2, CO3, CO4, CO5

Continuous Internal Evaluation (25 Marks)

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

Oral & 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
DSPEL 5011	Computer Network & Security Lab	-	25	25	-	-	50	

Prerequisite: Python or R Programming	
Course Objectives: The course aims	
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
4	To be able to analyze and implement public key algorithms like RSA.
5	To explore the different network reconnaissance tools to gather information about networks
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.
4	Analyze and implement public key algorithms like RSA.
5	Explore the different network reconnaissance tools to gather information about networks
6	Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.

Sr. No.	Suggested List of Experiments	CO Mapping
01	Demonstrate the different types of topologies by using a packet tracer tool. Use basic networking commands in Linux (ping, tracert, nslookup, netstat,	CO1

	ARP, RARP, ip, ifconfig, dig, route)	
02	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.	CO2
03	To design and Simulate VLANs on the switch/router using Cisco packet tracer	CO2
04	Perform File Transfer and Access using FTP (Cisco Packet Tracer)	CO2
05	Perform Remote login using Telnet server	CO3
06	Socket programming using TCP or UDP	CO3
07	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.	CO4
08	Implementation of Diffie Hellman Key exchange algorithm	CO4
09	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.	CO5
10	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc.	CO6
11	Study of packet sniffer tools wireshark:- 1. Observer performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters	CO6

Continuous Internal Evaluation (25 Marks)

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

Oral & Practical Exam (25 Marks)

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

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
DSPEL5012	Theory of Computation Lab	-	25	25	-	-	50	

Prerequisite: Python Programming	
Course Objectives: The course aims	
1	To understand the key concepts of NLP.
2	Provide hands-on understanding of automata theory concepts through simulation and coding.
3	Help students design and test Finite Automata (FA), Pushdown Automata (PDA), and Turing Machines (TM).
4	Enhance problem-solving skills in language recognition, parsing and computability.
Course Outcomes: Learners will be able to	
1	Apply various text processing techniques.
2	Construct and simulate various types of automata (FA, NFA, PDA, TM).
3	Analyze the equivalence and conversion between automata, grammars, and expressions.
4	Apply theoretical computation models to language recognition and syntax analysis problems
5	Demonstrate an understanding of decidability and computability concepts through simple simulations.

Sr. No.	Suggested List of Experiments	CO Mapping
1	Apply various text preprocessing techniques for any given text: Tokenization (a) Splitting Text into Words, Removing Punctuations (b) Extracting emails from documents, Normalizing whitespace	CO1
2	Apply various other text preprocessing techniques for any given text: Stop Word Removal. (a) Removing stop words, Extracting Hashtags,	CO1

	(b) Extracting dates from text, Detecting repeat words	
3	Finite Automata (a) Design a DFA for Even Binary Numbers. (b) NFA to DFA Conversion (c) Regular Expression to FA	CO2
4	Generate Strings from a Regular Grammar	CO2
5	CFG (a) CFG for Palindromes (b) Conversion of CFG to CNF	CO3
6	PDA for Balanced Parentheses	CO3
7	TM (a) TM for Unary Addition (b) TM for palindrome checking	CO3
8	Pumping Lemma Verification	CO3
9	Case Study: Application of Theory of Computation in Compiler Design	CO4
10	Mini Project: Design a small real-world problem (e.g., lexical analyzer using DFA).	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	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
DSPEL 5013	Nature Inspired Optimization Algorithms Lab	-	25	25	-	-	50	

Prerequisite: Python Programming	
Course Objectives: The course aims	
1	To understand the core principles and sources of inspiration for various nature-inspired algorithms (e.g., ant foraging, bird flocking, bat echolocation).
2	To develop practical skills in implementing these algorithms using programming languages like Python
3	To learn how to apply these algorithms to standard benchmark optimization problems and real-world scenarios.
4	To evaluate and compare the performance, efficiency, and limitations of different algorithms.
5	To foster problem-solving skills through hands-on experience in tuning algorithm parameters for optimal performance
Course Outcomes: Learners will be able to	
1	Formulate a given optimization problem such that it can be solved using nature-inspired algorithms.
2	Implement fundamental nature-inspired optimization algorithms (e.g., GA, PSO, ACO) from scratch using a programming language.
3	Apply various advanced metaheuristic algorithms (e.g., Firefly, Cuckoo Search, GWO, WOA) to find near-optimal solutions for complex problems.
4	Analyze the performance of different algorithms based on their convergence rate, efficiency, and solution quality.
5	Select an appropriate nature-inspired algorithm and tune its parameters effectively to solve specific real-world engineering or scientific problems
6	Document and present the results of experimental analysis, including graphical representations of convergence curves and performance metrics.

Sr.No	Suggested List of Experiments	CO Mapping
1	Implement a genetic algorithm to solve a classic optimization problem such as the Knapsack Problem or Traveling Salesman Problem.	CO1
2	Investigate the properties of the memristor, such as resistance modulation and memory effects, and explore its potential applications in neuromorphic computing	CO1
3	Apply particle swarm optimization or other swarm intelligence algorithms to perform clustering on a dataset such as the Iris dataset or customer segmentation data	CO2
4	Implement a quantum-inspired optimization algorithm, such as quantum annealing or quantum inspired genetic algorithms, to solve a combinatorial optimization problem	CO2
5	Simulate an ant colony optimization algorithm to find the shortest path in a graph	CO3
6	Develop a hybrid algorithm that combines multiple nature-inspired techniques, such as genetic algorithms and ant colony optimization, to solve a complex optimization problem.	CO3
7	Experiment with different crossover and mutation operators to observe their impact on convergence speed and solution quality	CO4
8	Investigate the properties of the memristor, such as resistance modulation and memory effects, and explore its potential applications in neuromorphic computing.	CO5
9	Implement a neuroevolution algorithm to evolve neural network agents for playing simple games like Tic-Tac-Toe or Flappy Bird	CO5
10	Develop an artificial immune system algorithm for anomaly detection in a synthetic dataset or network traffic data	CO6

Continuous Internal Evaluation (25 Marks)

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

Oral & Practical Exam (25 Marks)

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

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
CEMDML 501	**Database Management System Lab**	-	25	25	-	-	50	

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

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	CO1
2	Mapping ER/EER to Relational schema model.	CO1
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System	CO2
4	Apply DML Commands for the specified system	CO2
5	Perform Simple queries, string manipulation operations and aggregate functions.	CO3
6	Implement various Join operations.	CO4

7	Perform Nested and Complex queries	CO5
8	Perform DCL and TCL commands	CO2
9	Implement procedure and functions	CO5
10	Implementation of Views and Triggers	CO6

Continuous Internal Evaluation (25 Marks)

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

Oral & Practical Exam (25 Marks)
An Oral & Practical exam will be held based on entire syllabus.

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETMDML 501	Digital Communication and Sensor Technology Lab	-	25	-	-	-	25	

Prerequisite:	
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.

Sr. No.	Suggested List of Experiments	CO Mapping
01	To study and understand the basic elements of a digital communication system	CO1

02	To study and perform Pulse Code Modulation (PCM) and Demodulation of an analog signal.	CO1
03	To calculate the amount of information and entropy for a given discrete message source.	CO2
04	To design and implement Huffman coding for a given discrete source and calculate code efficiency and redundancy.	CO2
05	Linear block code generation and error detection	CO3
06	Cyclic code generation and error detection	CO3
07	Convolutional code generation	CO3
08	Line Codes generation and performance comparison	CO4
09	Generation (and detection) of Binary ASK, Binary PSK, and Binary FSK.	CO4
10	Generation (and detection) of QPSK	CO4
11	Study of Characteristics of a Potentiometer as a Displacement Sensor	CO5
12	Study of LVDT (Linear Variable Differential Transformer) Characteristics	CO5
13	Study of Capacitive Transducer for Displacement or Pressure Measurement	CO5
14	Study and Characterization of a Thermistor (Temperature Sensor)	CO6
15	Study of Photo-resistive Sensor (LDR) characteristics (Light intensity vs resistance)	CO6
16	Demonstration of MEMS-based sensors (e.g., accelerometer, pressure sensor using Arduino or NI-ELVIS)	CO6

Continuous Internal Evaluation (25 Marks)

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

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ARMDML501	**Mechatronics Lab**	-	25	25	-	-	50	

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.

Sr. No.	Suggested 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)

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 and 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 Hours
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					
ITMDML 501	**Sensors Actuators and Transducers Lab**	-	25	-	-	-	**25**	1

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.

Sr. No.	Suggested 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						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
MEMDML 501	Renewable Energy Sources Lab	-	25	--	-	-	25	

Prerequisite:	
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
4	
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

Sr. No.	Suggested List of Experiments (Any Five from Following List.)	CO Mapping
01	Demonstration on Solar Cooker	CO4
02	Demonstration on Solar Panel Test Rig.	CO4
03	Case Study on Wind Mill.	CO5
04	Study of Components of Wind Mill.	CO5
05	Study of Component & layout of thermal power plant.	CO2

06	Study of Component & layout of hydroelectric power plant.	CO2
07	Study of Mini & Micro Hydro Electric Plants	CO6
08	A case study on Energy Scenario & pattern of consumption of fossil fuel in Indian scenario.	CO1
09	Study of Component & layout of nuclear power plant.	CO3
10	Compulsory Visit to Any Renewable Source installation or conventional power plant.	CO1-CO6

Continuous Internal Evaluation (25 Marks)

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

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
EEMDML 501	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.

Sr. No.	Suggested List of Experiments	CO Mapping
01	Study of Smart Grid components.	CO5
02	Simulation on Modelling of PV system using MATLAB.	CO6
03	Simulation on Modelling of DFIG based wind power system.	CO6
04	Simulation of Grid connected PV MPPT single stage. CO1	CO6

05	To measure and analyze the power quality parameters with and without compensation. (voltage, THD, pf and current)	CO5
06	Simulation/Emulation of DC Microgrid with steady state/transient performance analysis	CO5
07	Simulation/ Emulation of AC Microgrid with steady state/transient performance analysis.	CO5
08	Study of solar PV charateristics	CO6
09	Study of constructional features and working principle of different special motors (Stepper, SRM, BLDC, PMSM, LIM).	CO1 to CO4
10	Speed control of a Stepper Motor using Arduino or Microcontroller Interface.	CO1
11	Determination of Step Angle and Resolution of Stepper Motor.	CO1
12	Characteristics of Switched Reluctance Motor (SRM).	CO2
13	Speed control of SRM using a power converter.	CO2
14	Study of Permanent Magnet Synchronous Motor (PMSM).	CO4
15	Experimental setup of PMSM drive using inverter and controller.	CO4
16	Study of BLDC motor and its characteristics.	CO3
17	Integration of special motor with sensor and control module for application (e.g., robotic arm / conveyor).	CO3

Virtual Lab Website Reference:

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

Virtual Lab Website Reference:

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

Continuous Internal Evaluation (25 Marks)

1. Lab Performance: 10 Marks
2. In-Semester Practical Exam during lab session: 10 Marks
3. Regularity and Attendance: 05 Marks

Department of Computer Science and Engineering (Data Science)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPCC601	**Deep Learning**	20	20	60	1	2	100	

Prerequisite: Linear Algebra, Probability & Statistics, Calculus, Programming (Python recommended), M**achine Learning Concepts, Artificial Neural Networks**	
Course Objectives: The course aims to	
1	Understand the fundamentals of Deep Learning and Neural Network Architectures.
2	Gain Knowledge on optimization and training techniques for deep neural networks.
3	Learn practical implementation of convolutional neural network models and its applicability to images.
4	Learn deep learning for text, time series, and sequential data using recurrent neural network models.
5	Explore advanced architectures such as transformers and generative models.
6	Apply deep learning models to real-world tasks.
Course Outcomes: Learners will be able to	
1	Explain the fundamentals of Deep Learning and Neural Network Architectures.
2	Apply optimization and training techniques for deep neural networks.
3	Analyze and implement convolutional neural network models.
4	Implement recurrent neural network for sequence modelling.
5	Investigate advanced architectures such as transformers and generative models
6	Develop and deploy deep learning solutions for real-world applications considering ethical implications.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Convolutional Neural Networks (CNN)** 1.1 Introduction to Convolutional Neural Networks, Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, Multichannel convolution operation,2D convolution 1.2 Image Classification, CNN architectures: LeNet, AlexNet, VGG, ResNet, EfficientNet 1.3 Transfer learning and fine-tuning 1.4 Data augmentation and regularization for vision tasks **Self-Learning Topic:** Applications in Computer Vision	07	CO1
02	**Recurrent Neural Networks (RNN)** 2.1 Introduction to sequence data (time series, text, audio, DNA), Sequence Learning, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of 'vanilla RNN' Vanishing and Exploding Gradients, Truncated BTT 2.2 Need for LSTM, LSTM architecture, Gates in LSTM: Forget Gate, Input Gate, Output Gate, GRU architecture, Update and Reset gates **Self-Learning Topic:** Difference between LSTM and GRU, Applications of LSTM and GRU	08	CO2
03	**Natural Language Processing (NLP)** 3.1 Natural Language Processing Basics: Levels of NLP, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP 3.2 Introduction to Markov Chains, Hidden Markov Models (HMMs), N –Grams, Unigrams/Bigrams Language Models 3.3 Text preprocessing: Tokenization, Stop-word removal, Stemming, Lemmatization, Word representations: One-hot Encoding, Word embeddings (Word2Vec, GloVe). 3.4 Syntax Analysis, Semantic and Pragmatic Analysis. **Self-Learning Topic:** NLP applications (Text Classification, Machine Translation, Information Retrieval, Question Answers System, Categorization, Summarization, Sentiment Analysis, Named Entity Recognition)	08	CO3

04	**Attention mechanism & Transformers** 4.1 Sequence-to-Sequence and Attention Models: Encoder-Decoder architecture, Sequence-to-Sequence models, Attention mechanism, Applications in machine translation and summarization 4.2 Transformers and Large Language Models: Transformer architecture, Self-attention and multi-head attention, Positional encoding, Pretrained language models: BERT, GPT, T5 4.3 Introduction to Generative AI, Generative vs discriminative models 4.4 Introduction to prompt engineering **Self-Learning Topic:** Text generation using LLMs, Applications: Chatbots	**08**	**CO4**
05	**Autoencoders & Generative Models** 5.1 Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders, Types of Autoencoders: Sparse autoencoders, Contractive autoencoders, Denoising autoencoders 5.2 Basic components of Variational Autoencoders (VAEs), Architecture and training of VAEs the loss function, Latent space representation and inference, Applications of VAEs in image generation 5.2 Generative Adversarial Networks (GANs) and Diffusion models, Generative Adversarial Networks (GANs) architecture, The discriminator model and generator model, GAN variants 5.3 Applications (Image generations, Deepfake) **Self-Learning Topic:** GAN Challenges- Training instability and model collapse	**07**	**CO5**
06	**Applications, Ethics, and Deployment** 6.1 Model interpretability, Model Evaluation and explainability (Grad-CAM, SHAP), Bias, Fairness, and Ethics in AI, Model compression, quantization, and deployment (ONNX, TensorFlow Lite, Flask APIs) **Self-Learning Topic:** Responsible AI	**04**	**CO6**

Text Books:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.

3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada —Introduction to Artificial Neural Systems‖, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. —Algorithms for Optimization‖, MIT Press.
6	Daniel Jurafsky and James H. Martin. 2026. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, 3rd edition. Online manuscript released January 6, 2026.
7	Dive into Deep Learning (D2L), Aston Zhang, Zachary C. Lipton, Mu Li, and Alex J. Smola
8	Foster, D., 2022. Generative deep learning. " O'Reilly Media, Inc.".
References:	
1	Deep Learning from Scratch: Building with Python from First Principles- Seth Weidman by O`Reilley
2	François Chollet. —Deep learning with Python —(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. —Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5	S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India
6	Natural Language Processing with Transformers, Book by Leandro von Werra, Lewis Tunstall, and Thomas Wolf
7	Koller, D. and Friedman, N., 2009. Probabilistic graphical models: principles and techniques. MIT press
Web Links:	
1	https://nptel.ac.in/courses/106/106/106106184/
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://www.deeplearningbook.org/
4	https://web.stanford.edu/~jurafsky/slp3

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

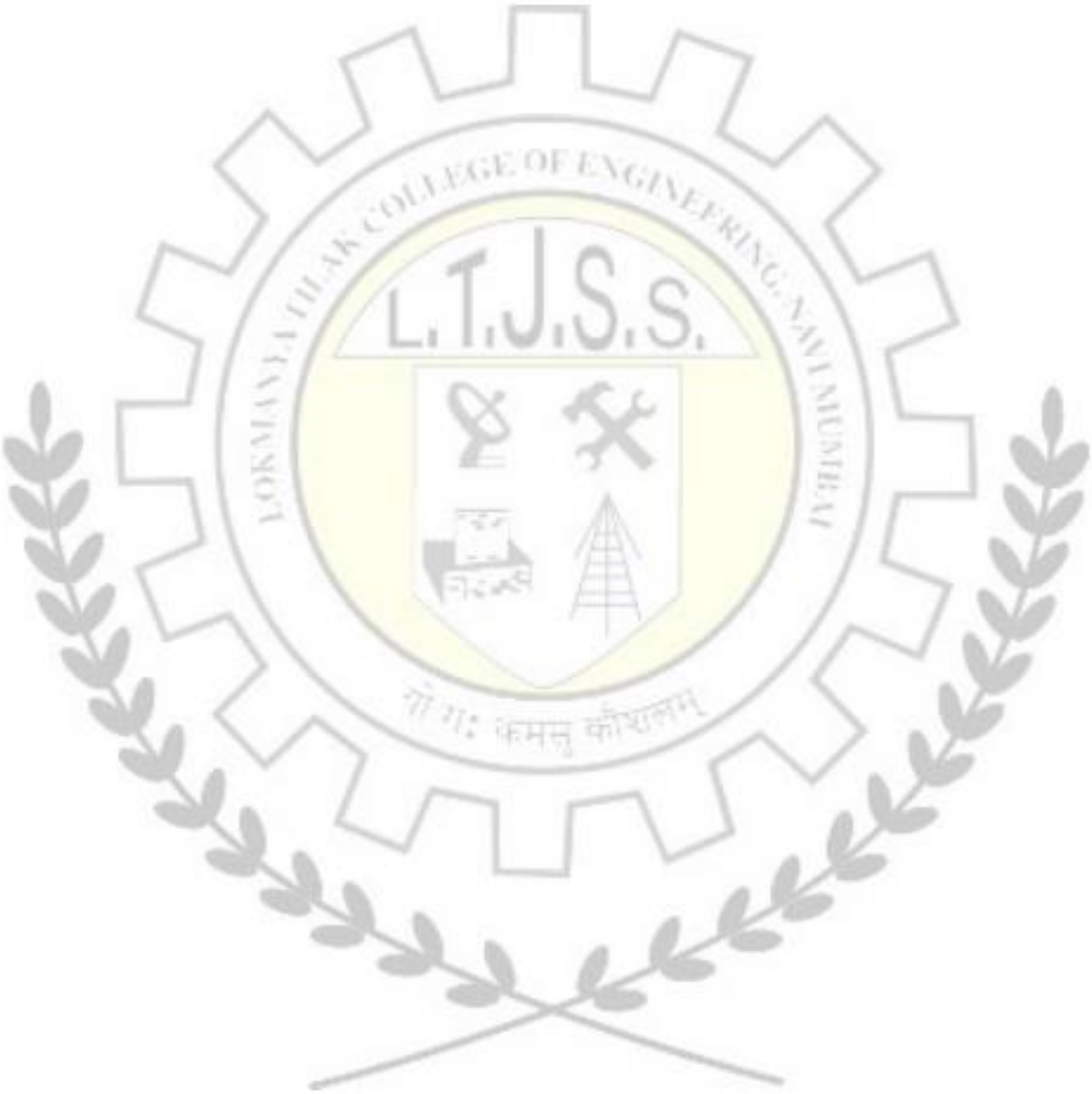
B. Continuous Internal Evaluation (20 Marks)

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPCC 602	Software Engineering and Project Management	20	20	60	1	2	100	

Prerequisite: Programming fundamentals, Data Analytics, Computer Network	
Course Objectives: The course aims to	
1	The objective of this course is to familiarize learners with different development frameworks
2	To demonstrate and evaluate real time projects with respect to software engineering principles and Apply testing and assure quality in software solution
3	To introduce the principles and processes of software engineering and DevOps.
4	To apply analysis, and develop software solutions
5	To Analyze software quality and testing strategies
6	To Develop skills in project scheduling and planning
Course Outcomes: Learners will be able to	
1	Understand and use basic knowledge in software engineering.
2	Apply software engineering principles for application development.
3	Apply DevOps principles, perform configuration management using automation tools, and manage containerized applications using Docker.
4	Be able to understand and implement DevOps principles for CI/CD
5	Apply testing process for application development. Generate project schedule and can construct, design and develop network diagram for different type of Projects. They can also organize different activities of project
6	Generate project schedule and can construct, design and develop network diagram for different type of Projects. They can also organize different activities of project

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Software Engineering** **1.1 Introduction:** Fundamentals of Software Engineering- process framework, Waterfall model, Software Development Life Cycle (SDLC) Process Models: Incremental and Evolutionary. **1.2 Software Requirements:** Functional & non-functional, Software requirement specification (SRS) 3Ps (people, product and process) Process and Project metrics Software. **1.3 User Interface Design:** The golden rules, Interface Design steps & Analysis, Design Evaluation. **1.4 Fundamentals of Agile Process:** Need of Agile software development, Agile Manifesto and Principles, Stakeholders and Challenges, Overview of Agile Development Models: Scrum, Extreme Programming, Feature Driven Development, Crystal, Kanban **Self -Learning Topic** –Lean Software Development, Business benefits of software agility.	09	CO1
02	**Software Risk and Maintenance** **2.1** Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough. **2.2** Source Code Management: Version Control: GIT Features, 3-Tree Architecture, GIT – Clone /Commit / Push **Self -Learning Topic** - GIT Hub Projects, GIT Hub Management, GIT Rebase & Merge, GIT Stash, Reset, Checkout, GIT Clone, Fetch, Pull, Membership GITHUB	05	CO2
03	**Continuous Integration and Deployment** **3.1 Continuous Integration:** Continuous Delivery and Deployment, Benefits of CI/CD, Metrics to track CI/CD practices, Continuous integration, tools, Build & Test Applications with Continuous Integration, **3.2** Scheduling build Jobs, Build Scripts, Build Pipeline, Master & Slave Node Configuration, Workspace Management, Security and plugins **Self-Learning Topic-**Successful AI Integration in Agile Testing Environments	06	CO3
04	**Introduction to Software Testing and Maintenance** **4.1 Continuous Testing:** Testing: Strategies for Conventional Software, Object oriented software, Web Functionality Testing, UI Testing,	06	CO4

	Performance Testing, Security Testing: Software Quality, Testing: Strategic Approach, Strategic Issues- Apps Validating Testing- System Testing- Art of Debugging. **4.2 Software Maintenance-** Software Supportability **4.3 Reengineering-** Business Process Reengineering-Software Reengineering-Reverse Engineering-Restructuring-Forward Engineering.		
	Self-Learning Topic - AI-Enabled Software Testing: Tools and Techniques Future Trends: Hyper automation, Autonomous Testing, and Self-Healing Systems		
05	**IT Project Management and Project Scheduling.**	**08**	**CO5**
	5.1 Introduction,4P's, W5HH Principle, Need for Project Management, Project Life cycle and ITPM. 5.2 Project Scheduling: Defining a Task Set for the Software Project, Timeline chartsWBS, Developing the Project Schedule, Network Diagrams (AON, AOA), CPM and PERT, Gantt Chart, Tracking the Schedule, Earned Value Analysis.		
	Self-Learning Topic- Project Feasibility, RFP, PMBOK Knowledge areas, Business Case, Project Planning, Project Charter and Project Scope.		
06	**Advanced Software Operations and Automation**	**08**	**CO6**
	6.1 DevOps -Intermediate DevOps- CI/CD Pipeline with Jenkins/GitHub Actions,Infrastructure as Code (IaC) with TerraformApp Monitoring Dashboard,GitOps with ArgoCD**,** **6.2 MLOps-** ML Model Development Best Practices, Machine Leaning (ML) Model Operations ML Model Deployment Best Practices **6.3 DataOps Pipeline Elements-** DataOps Implementation, Challenges of DataOps, DevOps Vs DataOps **6.4 AIOps** -AI in software development, AI's effect on the software development lifecycle (SDLC)		
	Self-Learning Topics- Advanced DevOps Projects		

Textbooks:

1. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill
2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
3. John M. Nicholas, Project Management for Business and Technology, 3rd edition, Pearson Education.

References:

1. Software Engineering: A Precise Approach‖ Pankaj Jalote , Wiley India
2. Ian Sommerville ― Software Engineering‖ 9th edition Pearson Education SBN-13: 978-0- 13- 703515-1, ISBN-10: 0-13-703515-2
3. PankajJalote, An integrated approach to Software Engineering, Springer/Narosa.

Useful Links

1. https://onlinecourses.swayam2.ac.in/cec21_cs21/preview
2. https://nptel.ac.in/courses/106101061
3. http://www.nptelvideos.com/video.php?id=911&c=9
4. https://onlinecourses.swayam2.ac.in/e-learning/course/cec26_cs06-mooc course for software Engineering
5. https://onlinecourses.swayam2.ac.in/e-learning/course/imb26_mg160
   MOOC COURSE -AI-Integrated Management of NEXT-GEN Software Testing

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 6011	Cloud and Distributed Networks	20	20	60	1	2	100	

Prerequisite: Computer Architecture, Operating System and Networking concepts	
Course Objectives: The course aims to	
1	To understand the fundamentals of cloud computing and distributed network architectures.
2	To study virtualization, SDN, and network virtualization concepts.
3	To learn distributed algorithms for synchronization, communication, and fault tolerance
4	To explore cloud-based frameworks and tools for large-scale data processing.
Course Outcomes: Learners will be able to	
1	Explain cloud computing concepts and architectures.
2	Apply virtualization and SDN techniques in cloud environments.
3	Implement distributed algorithms for coordination and synchronization.
4	Analyze NoSQL and cloud storage systems.
5	Compare P2P and cloud-based distributed systems.
6	Use cloud frameworks like MapReduce, Spark, and Kafka for data processing.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Clouds, Virtualization, and Virtual Machines** 1.1 Introduction to Cloud Computing, Cloud Computing vs. Distributed Computing 1.2 Features of Today's Clouds, AAS Classification, 1.3 Categories of Clouds- Private, Public, Hybrid, Community, 1.4 Virtualization Concepts, Types of Virtualization- Processor, Memory, Full, Para, Device Virtualization	07	CO1

	Self-learning: Docker and Linux Container Basics		
02	**Network Virtualization and Geo-Distributed Clouds** 2.1 Approaches for Networking of Virtual Machines-Hardware & Software 2.2 Software Defined Networking (SDN) 2.3 Multi-tenant Data Centres: Design and Networking Challenges, 2.4 Cloud Storage Models: Object, Block, and File Storage 2.5 Networking in Cloud: Virtual Networks, Load Balancers, Elastic IPs **Self-learning:** Overview of Major Cloud Providers: AWS, Azure, GCP	**07**	**CO2**
03	**Classical Distributed Algorithms** 3.1 Time and Clock Synchronization in Cloud Data Centers, challenges 3.2 Clock Skew, Drift, Christians Algorithm, Berkeley's, and NTP Algorithms 3.3 Logical Ordering**:** Lamport and Vector Timestamps 3.4 Global State & Snapshot**:** Chandy-Lamport Algorithm 3.5 Distributed Mutual Exclusion**:** Lamport's, Ricart-Agrawala, and Maekawa's Algorithms 3.6 Deadlocks**:** Detection and Handling. **Self-learning**: Google Chubby Lock Service	**08**	**CO3**
04	**Cloud Storage Systems and NoSQL Databases** 4.1 Key-Value/NoSQL Data Model and Abstraction 4.2 Design of Apache Cassandra: Data Placement Strategies, Snitches, Writes, Compaction, Membership, Bloom Filter, Eventual Consistency, 4.3 CAP Theorem, Consistency Levels 4.4 Design of HBase: Architecture, Data Model, Storage Hierarchy 4.5 Auto-sharding, Bloom Filters, Cross Datacentre Replication and Fault Tolerance	**07**	**CO4**
	Self-learning: Study of these tools - MongoDB Atlas**,** DataStax Astra**, or** Google Bigtable Emulator		
05	**Peer-to-Peer (P2P) Systems and Industry Applications** 5.1 P2P Systems in Cloud Environments 5.2 P2P Architectures: Centralized, Decentralized, Hybrid 5.3 Case Studies: Napster, Gnutella, FastTrack, BitTorrent, Distributed Hash Tables (DHTs): Chord, Pastry, Kelips, Data Lookup, Consistency, and Replication Strategies, 5.4 Applications of P2P in Industry and Cloud Ecosystems	**07**	**CO5**
	Cloud Applications and Distributed Frameworks 6.1 MapReduce Paradigm: Programming Model, Applications,		

06	Scheduling, Fault-Tolerance 6.2 Examples Apache Spark: RDDs and Operations Spark 6.3 Applications: PageRank Algorithm GraphX and GraphX API 6.4 Apache Kafka: Introduction, Use Cases, Architecture, Data Model, Brokers 6.5 Importance of Messaging Systems in Cloud	**06**	**CO6**
	Self-learning: Case Study: Using MapReduce for log analysis or social media sentiment analysis		

Text Books:

1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, 'Cloud Computing: Principles and Paradigms', Wiley.
2. George Coulouris et al., ' Distributed Systems: Concepts and Design', Pearson.
3. Thomas Erl, 'Cloud Computing: Concepts, Technology & Architectur', Pearson.
4. Kai Hwang, Geoffrey Fox, Jack Dongarra, 'Distributed and Cloud Computing', Morgan Kaufmann.

References:

1. Arshdeep Bahga, Vijay Madisetti, 'Cloud Computing: A Hands-On Approach'.
2. Jeffrey Dean, Sanjay Ghemawat, 'MapReduce: Simplified Data Processing on Large Clusters'.
3. Apache Documentation: Spark, Kafka, HBase, Cassandra.

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs15/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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 6012	Embedded System and IoT	20	20	60	1	2	100	

Prerequisite: Microprocessor and Microcontroller, Computer Network and Security	
Course Objectives: The course aims to	
1	Understand the fundamentals of embedded systems and their hardware–software co-design
2	To learn advances in Embedded Systems and IoT
3	To learn methodologies for IoT application development
4	To learn the IoT protocols, cloud platforms and security issues in IoT
5	To learn real world application scenarios of IoT along with its societal and economic impact using case studies and real time examples
Course Outcomes: Learners will be able to	
1	Explain architecture and components of embedded systems
2	Describe the Characteristics and Conceptual Framework of IoT
3	Apply design methodology for designing and implementing IoT applications
4	Learn IoT related protocols and specifications.
5	Design and demonstrate an end-to-end IoT prototype integrating embedded hardware and cloud services.
6	Analyze IoT security requirements, mechanisms and security models for secure IoT application design.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Embedded Systems** 1.1 Definition, Characteristics of Embedded System, Types of Embedded systems 1.2 Components of ES: Hardware and software, system-on-chip (SoC). 1.3 Hardware components of ES: Power supply: types, characteristics, selection criteria, Processing Unit, Input devices, Output Devices **Self-learning Topics**: Study of popular microcontrollers: ARM Cortex-M, RISC-V, and ESP32.	07	CO1
02	**Internet of Things : Concepts** 2.1 Introduction to IoT- Defining IoT, Characteristics of IoT 2.2 Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Brief review of applications of IoT. 2.3 Things in IoT: Sensors : Roles of Sensors & Actuators, Types of sensors, Smart Object – Definition, Characteristics and Trends **Self-Learning Topic:** Hardware and software development tools for - Arduino, NodeMCU, ESP32, Raspberry Pi	07	CO2
03	**IoT: Design Methodology** 3.1 Introduction to IoT Design Process 3.2 Basics of IoT Networking, Networking Components, Internet Structure, Connectivity Technologies, IoT service oriented architecture, Design of gateways 3.3 IoT Communication Models and IoT Communication APIs, Sensor Networks 3.4 Four pillars of IoT: M2M, SCADA, WSN, RFID. **Self-Learning Topic:** Study real-world design documentation of Smart Home Systems (Google Nest, Amazon Echo)	07	CO3
04	**IoT Protocols** 4.1 Protocol Standardization for IoT, M2M and WSN Protocols, 4.2 RFID Protocol, Modbus Protocol, Zigbee Architecture, Z-wave 4.3 IP based Protocols: MQTT (Secure), CoAP, 6LoWPAN, LoRa. 4.4 Streaming Text Oriented Message Protocol (STOMP), Advanced Message Queuing Protocol (AMQP) **Self-Learning Topic**: Generic web based protocols	06	CO4

05	**IoT Cloud Integration and Applications** 5.1 Concept of Cloud Computing: Everything as a Service (XaaS), Role of Cloud, Need for Cloud in IoT Ecosystems, Benefits of IoT-Cloud integration 5.2 Advanced topics - Data Analytics for IoT, Fault Tolerance in IoT based Systems 5.3 Cloud IoT platforms: AWS IoT, Azure IoT Hub, Google Cloud IoT Core, ThingsBoard. **Self-Learning Topic:** Case studies: smart home, industrial IoT, healthcare applications.	08	CO5
06	**Security in IoT** 6.1 Introduction, Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling. 6.2 Key elements of IoT Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability 6.3 Security model for IoT, Challenges in designing IOT applications, lightweight cryptography. **Self-Learning Topic:** Study Blockchain for IoT Security– decentralized identity and data integrity	07	CO6

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, 2nd Edition,Wiley Publication, ISBN: 978-1-119-99435-0

References:

1. Dawoud Shenouda Dawoud, Peter Dawoud, “Microcontroller and Smart Home Networks”, ISBN: 9788770221566, e-ISBN: 9788770221559
2. Charles Crowell, “IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT”,ISBN-13 : 979-8613100194
3. David Hanes, Gonzalo Salgueiro, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, ISBN-13: 978-1-58714-456-1 ISBN-10: 1-58714-456-5
4. David Etter, “IoT Security: Practical guide book”, amazon kindle Page numbers, source ISBN : 1540335011.
5. Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Second Edition, Packt Publishing, ISBN: 9781788625821

Useful Link:

1. https://www.coursera.org/learn/iot

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 6013	Graph Data Science	20	20	60	1	2	100	

Prerequisite: Data Structure, Graph Theory, Machine Learning	
Course Objectives: The course aims to	
1	To Understand the basics of graphs, including definitions, connectivity, and properties.
2	To Explore the use of graphs in solving puzzles and optimization problems.
3	To Learn about the advantages of graph databases over relational and NoSQL databases.
4	To Gain knowledge of data modeling with graphs, including the labeled property graph model.
Course Outcomes: Learners will be able to	
1	Demonstrate a solid understanding of graph concepts and properties.
2	Apply graph algorithms to solve puzzles and optimization problems.
3	Compare graph databases with relational and NoSQL databases.
4	Model data using the labeled property graph model and avoid common pitfalls.
5	Build graph database applications with proper data modeling and testing.
6	Analyze and implement graph database solutions for real-world use cases, considering non-functional characteristics

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Graph** 1.1 Definitions and examples, Three puzzles, Paths and cycles, Connectivity 1.2 Eulerian graphs, Hamiltonian graphs, shortest path, Chinese postman problem, traveling salesman problem, trees, properties of trees	04	CO1
	Introduction to Graph Database		

02	2.1 A High-Level View of the Graph Space, Graph Databases, Graph Compute Engines 2.2 The Power of Graph Databases, Performance, Flexibility, Agility, Options for Storing Connected Data 2.3 Relational Databases Lack Relationships, NOSQL Databases Also Lack Relationships, Graph databases embraces relationship	**07**	**CO2**
03	**Graphs in the Real World**	**07**	**CO3**
	3.1 Organizations Choose Graph Databases, Common Use Cases, Real-World Examples, Authorization and Acces Control, Geospatial and Logistics 3.2 Graph Database Internals, Native Graph Processing, Native Graph Storage Programmatic APIs, Kernel API, Core API, Traversa Framework, Non-functional Characteristics		
04	**Connectivity and paths**	**08**	**CO4**
	5.1 Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem. 5.2 Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings.		
05	**Graph data science techniques and tools**	**07**	**CO5**
	5.1 Graph algorithms,Graph feature engineering, Graph embeddings Graph mining, Graph Neural Networks (GNNs), Graph databases and query languages 5.2 Graph data science tools: PuppyGraph Neo4j NetworkX PyTorch Geometric TigerGraph		
06	**Neo4j Graph data science**	**05**	**CO6**
	6.1 Neo4j – About, Neo4j – Installation, Neo4j – Browser Neo4j - Query Language (Cypher), Neo4j - Create a Node Neo4j - Create a Relationship, Neo4j - Create an Index Neo4j - Create a Constraint, Neo4j - Select Data with MATCH, Neo4j - Import Data from CSV, Neo4j - Drop an Index, Neo4j - Drop a Constraint, Neo4j - Delete a Node, Neo4j - Delete a Relationship		

Text Books:

1. Introduction to Graph Theory Fourth edition, Robin J. Wilson
2. Daphne Koller and Nir Friedman, 'Probabilistic Graphical Models: Principles and Techniques'
3. Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2).
4. Graph databases, Ian Robinson, Jim Webber & Emil Eifrem

References:

1 'Graph Databases: New Opportunities for Connected Data' by Ian Robinson, Jim Webber, and Emil Eifrém.
2 'Neo4j in Action' by Aleksa Vukotic, Nicki Watt, and Tareq Abedrabbo.
3 'Graph Databases for Beginners' by Mark Needham and Amy E. Hodler.

4 ‘Practical Neo4j’ by Gregory Jordan.
5 ‘Learning Neo4j’ by Rik Van Bruggen.
6 ‘Graph Database Applications and Concepts with Neo4j’ by Dionysios Synodinos.

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 6021	Social Network Analytics	20	20	60	1	2	100	

Prerequisite: Graph Theory, Computer Network, Python Programming	
Course Objectives: The course aims to	
1	Understand the fundamentals of social networks, key concepts, and graph representations.
2	Develop the ability to model and analyze real-world networks using graph theory principles.
3	Compute and interpret network metrics to assess connectivity, centrality, and influence.
4	Explore and apply community detection and link analysis techniques.
5	Understand and simulate information diffusion and link prediction models in social networks.
6	Learn advanced concepts like graph embeddings, graph neural networks, and ethical issues in social data analysis.
Course Outcomes: Learners will be able to	
1	Describe the fundamental concepts, structures, and representations of social networks using graph theory.
2	Apply graph theory principles to model and analyze different types of real-world network structures.
3	Compute and interpret various network metrics to evaluate node importance, connectivity, and influence
4	Identify and evaluate communities and clusters within large networks using modularity-based techniques.
5	Examine and simulate information diffusion and link prediction processes in complex social networks.

Module	Detailed Contents	Hrs.	CO Mapping

01	**Introduction to Social Network Analysis (SNA)** 1.1 Definition and scope of Social Network Analysis (SNA). 1.2 Types of networks – personal, organizational, information, and biological networks. 1.3 Network representation – adjacency matrix, incidence matrix, edge list. 1.4 Network properties – homophily, transitivity, reciprocity, degree distribution. 1.5 Real-world examples – Facebook, Twitter, LinkedIn, citation networks. 1.6 Network visualization using Gephi and Python (NetworkX). **Self-learning Topics :** Real-world network datasets, NetworkX basics, Gephi visualization, Neo4j graph databases	**06**	**CO1**
02	**Graph Theory Foundations and Network Models** 2.1 Basics of graph theory – nodes, edges, degree, paths, connectivity, and components. 2.2 Types of graphs – directed, undirected, weighted, unweighted, bipartite. 2.3 Random network model (Erdős–Rényi model). 2.4 Small-world network model (Watts–Strogatz model). 2.5 Scale-free networks and preferential attachment (Barabási–Albert model). 2.6 Power-law distributions and their implications. 2.7 Link analysis – PageRank and HITS algorithms. **Self-Learning Topic:** Random, Small-world and Scale-free models, PageRank algorithm, Power-law degree distribution	**08**	**CO2**
03	**Network Metrics and Structural Analysis** 3.1 Centrality measures – degree centrality, closeness centrality, betweenness centrality, eigenvector centrality. 3.2 Local and global clustering coefficient. 3.3 Network density, path length, and diameter. 3.4 Structural holes, bridges, and Burt's constraint. 3.5 Core–periphery structures and assortativity. 3.6 Network motifs and subgraph patterns. **Self-Learning Topic:** Eigenvector and Katz centrality, Ego network visualization, Structural holes and bridges	**08**	**CO3**
04	**Community Detection and Network Partitioning** 4.1 Concept of community and modularity. 4.2 Modularity optimization and quality evaluation. 4.3 Community detection algorithms – Girvan–Newman, Louvain, Label Propagation.	**07**	**CO4**

	4.4 Overlapping and hierarchical communities. 4.5 Visualization and interpretation of communities		
	Self-Learning Topic: Spectral clustering, Modularity and NMI metrics, Community detection applications		
05	**Information Diffusion and Link Prediction**	**07**	**CO5**
	5.1 Information diffusion and influence propagation. 5.2 Diffusion models – Independent Cascade (IC) and Linear Threshold (LT). 5.3 Viral marketing and influence maximization. 5.4 Link prediction – similarity-based (common neighbours, Jaccard, Adamic-Adar). 5.5 Learning-based link prediction approaches. 5.6 Applications in recommender systems.		
	Self-Learning Topic: Temporal diffusion patterns, ML-based link prediction, Link prediction evaluation metrics		
06	**Advanced Topics and Applications**	**06**	**CO6**
	6.1 Anomaly detection in social networks. 6.2 Temporal and dynamic networks. 6.3 Graph representation learning – Node2Vec, DeepWalk. 6.4 Graph Neural Networks (GNNs) and Graph Convolutional Networks (GCN). 6.5 Applications – fake news detection, influencer marketing, recommendation systems. 6.6 Ethical and privacy issues in network data.		
	Self-Learning Topic: Graph Neural Networks (GNN, GCN), Dynamic graph embeddings, Ethical and privacy issues.		

Text Books:

1. Wasserman, S. and Faust, K., **"**Social Network Analysis: Methods and Applications", Cambridge University Press.
2. Newman, M. E. J**.,** "Networks: An Introduction"**,** Oxford University Press.
3. Matthew A. Russell, "Mining the Social Web**"**, O'Reilly Media.R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa.
4. K. R. Venugopal and L. M. Patnaik, "Foundations of Algorithms", Narosa Publishing House, New Delhi.
5. Chakraborty, T. – "Social Network Analysis*"*, Wiley (2021).
6. Barabási, A.-L. – "Network Science", Cambridge University Press

References:

1. https://nptel.ac.in/courses/106106169

2. https://nptel.ac.in/courses/106106221
3. https://nptel.ac.in/courses/106105195
4. https://nptel.ac.in/courses/106106198

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
DSPEC 6022	**Recommendation System**	20	20	60	1	2	100	

Prerequisite: Artificial Intelligence and Machine Learning, Basic knowledge of Python	
Course Objectives: The course aims to	
1	To introduce Recommendation systems and it's basic concepts.
2	To understand design and working of Collaborative Filtering based recommendation.
3	To analyze design and working of Content-based recommendation.
4	To understand design and working of Knowledge based recommendation.
5	To understand design and working of Ensembled- Based and Hybrid Recommendation Systems.
6	To identify the methods for evaluation of recommendation systems.
Course Outcomes: After successful completion of the course student will be able to	
1	To have a broad understanding of the field of Recommendation Systems.
2	In-depth Knowledge of the architecture and models for Collaborative Filtering.
3	Understanding the architecture and working of Content based recommendation systems.
4	Understanding the architecture and basics of Knowledge based recommendation systems.
5	Analyzing hybrid and ensembles recommendation systems.
6	Evaluation of recommendation systems by selecting right evaluation parameter.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Introduction to Recommendation System** 1.1 History of recommendation system, Eliciting Ratings and other Feedback Contributions, Implicit and Implicit Ratings, Recommender system functions.	06	CO1

	1.2 Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.		
02	**Collaborative Filtering** 2.1Architecture of Collaborative Filtering, User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, 2.2 Clustering for recommendation system, Attacks on collaborative recommender systems, Advantages and drawbacks of Collaborative Filtering.	**07**	**CO2**
03	**Content-based recommendation** 3.1 Architecture of content-based systems, Content representation and content similarity, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, The Role of User Generated Content in the Recommendation Process. 3.2 Bayes classifier for recommendation, Regression based recommendation system. Advantages and drawbacks of content-based filtering	**07**	**CO3**
04	**Knowledge based recommendation** 4.1Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders, 4.2 Persistent Personalization in Knowledge-Based Systems, Conversational Recommendation. Search based recommendation 4.3 Navigation-based recommendation	**07**	**CO4**
05	**Ensembled- Based and Hybrid Recommendation System** 5.1 Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, 5.2 Parallelized hybridization design: Weighted, Switching, Mixed 5.3 Pipelined hybridization design: Cascade Meta- level, Limitations of hybridization strategies.	**07**	**CO5**
06	**Evaluating Recommendation System** 6.1 Characteristics and properties of evaluation research, Evaluation design goals- Accuracy, Coverage, Confidence and Trust, Novelty, Serendipity, Diversity, Robustness, Stability and Scalability. 6.2 Comparison between evaluation design of classification model and recommendation system, Error metrics, Decision-Support metrics, User-Centred metrics. Comparative analysis between different types of recommendation systems.	**08**	**CO5**

Text Books:

1. Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). Recommender systems: an introduction.Cambridge University Press.
2. Ricci, F., Rokach, L., & Shapira, B. (2011). Introduction to Recommender Systems Handbook. Springer,Boston, MA.

References:

1. Aggarwal, C. C. (2016). Recommender systems (Vol. 1). Cham: Springer International Publishing.

Useful Links:

1. http://www.iem.iitkgp.ac.in/eco/Recommender_Systems/
2. https://www.coursera.org/specializations/recommender-systems
3. https://www.udemy.com/course/recommender-systems/
4. https://www.analyticsvidhya.com/blog/2021/08/developing-a-course-recommender-system- using-python/

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	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					4
DSPEC 6023	Explainable Artificial Intelligence (XAI)	20	20	60	1	2	100	

Prerequisite: Basic Mathematics, Analysis of Algorithm, Deep Learning	
Course Objectives: The course aims to	
1	Understand the fundamental concepts, evolution, and significance of Explainable Artificial Intelligence (XAI).
2	Explore and categorize various methods, forms, and frameworks used for building XAI models.
3	Explore explain-ability in deep learning and NLP models, including attention-based and saliency-based techniques.
4	Analyze the multidisciplinary applications of XAI, Intrinsically explainable models
5	Apply visual explanations techniques such as PDP, ICE, Surrogate Models, and Feature Importance.
6	Understand the ethical, regulatory, and human-centric considerations involved in designing trustworthy and XAI systems.
Course Outcomes: Learners will be able to	
1	Understand the fundamental concepts, types, and stakeholders of Explainable AI & Justify the need for explainability in AI systems.
2	Apply explainability techniques to various machine learning models and data types & Implement as well as compare various XAI methods.
3	Analyze deep learning models using explainability tools such as saliency maps and attention visualizations.
4	Evaluate the communication, regulatory, ethical, and usability aspects of XAI.
5	Apply visual explanations techniques such as PDP, ICE, Surrogate Models, and Feature Importance.

6	Apply XAI in real-world domains like healthcare, finance, legal tech, etc

Module	Detailed Contents	Hrs.	CO Mapping
01	**Foundations of Explainable Artificial Intelligence**	09	CO1
	1.1 Introduction to XAI, importance, Interpretable vs. black-box models		
	1.2 Stakeholders, types of explanations (premodeling, local/global, post hoc), interpretability, taxonomy. AI terminologies Dimensions of interpretability		
	1.3 Ethical and legal implications (GDPR, etc.), Types of explainability and Taxonomy, Explainability in the model development process.		
	Self-learning Topics: Evolution of Explainaible AI		
02	**Explainability for Structured and Visual Data:**	06	CO2
	2.1 Broad taxonomy of XAI methods including Intrinsic vs post hoc, model-specific vs model-agnostic, and local vs global. Propagation-based feature attribution methods (e.g., Relevance Propagation, Saliency methods, etc.) Tools: ELI5, LIME		
	2.2 Explainability for tabular and image data using SHAP, PDP, ICE, Grad-CAM, LIME, Guided Backprop, XRAI, etc		
	Self-Learning Topic: Introduction, An Example Use Case: Computational Pathology XAI Methods and Their Classifications, Forms of Explanation.		
03	**Explainability for Text and Advanced Topics:**	09	CO3
	3.1 XAI for Natural Language Processing: Attribution methods for NLP, Challenges in interpreting language models		
	3.2 LIME for text, embeddings, Attention and explainability in Transformers		
	3.3 Feature visualization, Saliency maps, Concept activation vectors (TCAV) Grad-CAM, and LRP, alternative and multimodal explainability, time series, evaluation methods.		
	Self-learning topic: Diversity of Motives for Creating Explainable AI, Contradiction Between the Motives for Creating Explainable AI.		
	Intrinsically explainable models		

04	4.1 Intrinsically explainable models including Linear Regression, Logistic Regression, Generalized Linear Model (GLM), Generalized Additive Model (GAM), and Decision Tree.	**06**	**CO4**
	4.2 Presenting explanations, interacting with stakeholders, pitfalls, regulatory aspects ML lifecycle, and future of explainability		
	Self-learning topic: The Multidisciplinary Nature of Explainable AI in Healthcare.		
05	**Visual Explanations**	**06**	**CO5**
	5.1 XAI methods include Partial Dependence Plot (PDP), Conformal Prediction, Individual Conditional Expectation (ICE), Feature Importance, and Saliency Maps.		
	5.2 Local Interpretable Model-Agnostic Explanations (LIME), SHAP, Integrated Gradient (IG) Evaluation of explainability		
	Self-learning Topics: Paradigm Shift of Explainable AI, Proposed AI Model, Proposed Architecture.		
06	**Trustworthy AI**	**06**	**CO6**
	6.1 Interpret the ethical and regulatory requirements for trustworthy AI and demonstrate understanding of human-AI interfaces.		
	6.2 Case study on AI applications in Healthcare, Retail, Banking..		
	Self-learning topics: Regulatory Requirements for Trustworthy AI, Explicability—An Ethical Principle for Trustworthy AI		

Textbooks:	
1	Munn, M., & Pitman, D. (2022). Explainable AI for practitioners: Designing and implementing explainable ML solutions (Grayscale Indian ed.). O'Reilly Media.
2	"Explainable AI: Foundations, Developments, Prospects and Challenges" by Wilfried Grossmann
3	"Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" edited by Samek et al.
References:	
1	George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.
2	D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3	Saroj Kaushik "Artificial Intelligence", Cengage Learning.

4	Patrick Hall et al. – *Machine Learning for High-Stakes Decisions* (O'Reilly, 2024)
5	Sameer Singh et al. – *Explainable AI in Practice* (Springer, 2021)
6	Denis Rothman "Hands-On Explainable AI (XAI with Python", Packt Publishing, 2020.
	WEB SOURCES: Interpretable Machine Learning" by Christoph Molnar (open access) IBM. (n.d.). Explainable AI. Retrieved May 19, 2025, from https://www.ibm.com/think/topics/explainable-ai TDAN. (n.d.). Explainable AI: 5 open-source tools you should know. Retrieved May 19, 2025, from https://tdan.com/explainable-ai-5-open-source-tools-you-should-know/31589

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	42 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**	6	CO2

	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.		
03	**NoSQL** 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 MapReduce.	**6**	**CO4**
05	**Techniques in Big Data Analytics** Finding Similar Item: Nearest Neighbour Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard, Cosine, Edit and Hamming Distance with its Examples Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter. Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	**14**	**CO5**
06	**Big Data Analytics Applications** Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Networks. Clustering of Social Graphs: Applying Standard Clustering Techniques, counting triangles using Mapreduce.	**7**	**CO6**
	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
4. https://onlinecourses.nptel.ac.in/noc25_cs131/preview

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 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	06	CO1

	model.		
	Self Learning Topic: Sampling and Quantization		
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 Topic:** Medical application of Image processing	04	**CO6**

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 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:	
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	**08**	**CO2**

	other grippers, Tool as end effecter. Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment		
03	**Machine vision & Programming for Robots:** **Machine vision** Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications. **Programming for Robots** Method, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	**09**	**CO3**
04	**Robot Kinematics & Robot Dynamics:** Robot Kinematics Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics. Introduction to wheeled and legged robots including humanoids.	**08**	**CO4**
05	**Robot Intelligence & Task Planning:** Robot Intelligence & Task Planning Introduction, State space search, Problem reduction, use of predictive logic, Means Ends Analysis, Problem solving, Robot learning and Robot task planning.	**07**	**CO5**
06	**Robot application:** Robot application in manufacturing Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, social issues & Economics of Robotics. Introduction to AI in Robotics industrial safty standards in robotics, Recent trends in robotics like service,Medical,humanoid robot,Softrobotics.	**06**	**CO6**

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

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

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
ITMDM 601	Microcontrollers and Application	20	20	60	1	2	100	

Prerequisite: Digital Electronics, Number system	
Course Objectives: The course aims to	
1	Understand the features and architecture of PIC 18 microcontroller and Ardino UNO
2	Introduce assembly programming knowledge for PIC 18 microcontroller
3	Impart embedded programming knowledge for PIC 18 microcontroller using C
4	Introduce various applications using microcontroller-based system
Course Outcomes: Learners will be able to	
1	Explain difference between microprocessor and microcontroller architecture and memory
2	Understand PIC 18 instruction and assembly level Programing
3	Describe the timer, counter and interrupt module of PIC 18 with assembly program
4	Explain the serial and parallel I/O with simple assembly program
5	Understand the 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	6	**CO1**

	Memory Pointers*:* Program ROM and Program Counter (PC), Data ROM		
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						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 Hrs
		Internal Assessment		End Semester Exam (ESE)	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					3
MEMDM 601	**Automobile System**	20	20	60	1	2	100	

Prerequisite:	
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	07	**CO1**

	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		
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.)	07	**CO6**

	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.		

Text Books:

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

References:

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

Internal Assessment (40 Marks)

A. Mid Semester Exam (20 Marks)

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

B. Continuous Internal Evaluation (20 Marks)

1. Assignment: 5 Marks
2. Quiz/Visit/Presentation: 10 Marks
3. Regularity and attendance: 5 Marks

End Semester Examination (60 Marks)

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

Course Code	Course Name	Examination Scheme						Lecture
		Marks Distribution			Exam Duration (Hrs)		Total Marks	42 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.	06	CO1

	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.		
02	**Drive train Topologies**	**06**	**CO2**
	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		
03	**DC and AC machines and drives for propulsion application**	**08**	**CO3**
	3.1 DC and AC machines used in EV/HEV, Electrical system components. 3.2 Features of DC and AC Motors for EV/HEV propulsion. 3.3 Permanent magnet (BLDC) and switch reluctance machines, configuration and control of drives.		
	Self-Learning Topic: comparision 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-Learning Topic: Basics of cell, overview of battery.**		
05	**Drive train modeling in EV/HEV**	**07**	**CO5**
	5.1 Modeling and analysis of EV/HEV drive train: Total tractive force calculation, sizing Of motor 5.2 Power electronics drive used in EV/HEV		
	Self-Learning Topic: Basic electronic components guidelines.		
06	**Energy management strategies in EV/HEV**	**07**	**CO6**
	6.1 EV/HEV energy management strategies, classification of various energy management strategies. Rule based EMS, optimization methods of EMS. 6.5 Standards for EV and HEV. Case studies.		

	Self-Learning Topic: 2w and 3w EV/HEV vehicles.		

Text Books:

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

Reference Books:

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

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: 05 Marks
2. Quiz/Open book test/Presentation: 10 Marks
3. Regularity and attendance: 05 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)	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE	Total Marks	Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					
DSPCL601	Deep Learning Lab	-	25	25	-	-	50	1

Prerequisite: Artificial Neural Networks, Python programming	
Course Objectives: The course aims to	
1	Understand deep learning models
2	Fine tune and evaluate DNN models
3	Learn CNNs, RNNs, LSTMs, Autoencoder, GAN models
4	Apply transfer learning
5	Design complete AI solutions
6	Understand basics of Generative AI and Transformer architecture
Course Outcomes: Learners will be able to	
1	Build and train deep learning models
2	Improve DNN model performance
3	Train CNNs, RNNs, LSTMs, Autoencoder, GAN models to solve real world problem
4	Implement transfer learning using pre-trained models
5	Design and deploy complete AI solutions
6	Generate text using Gen AI models

Sr. No.	Suggested List of Experiments	CO Mapping
1	Implement Perceptron and Multilayer Neural Network	CO1
2	Train Deep Networks using Optimization Algorithms	CO2
3	Train a simple classifier on MNIST or CIFAR-10	CO2
4	Image Classification using CNN	CO3

5	Sentiment Analysis using LSTM	CO3
6	Computer Vision: Face mask detection, Plant disease detection, Handwritten digit recognizer (anyone)	CO3
7	NLP: Chatbot, Fake news detection, Sentiment analyzer	CO3
8	Time Series: Stock prediction, Energy demand forecasting (anyone)	CO3
9	GAN-based Image Generation	CO3
10	Implement a VAE for image reconstruction	CO3
11	Transfer Learning using Pre-trained Models (VGG16, ResNet50, MobileNet)	CO4
12	Transformer-based Text Classification	CO4
13	Object detection using YOLO	CO5
14	Semantic segmentation using U-Net	CO5
15	Text Generation using GPT Model	CO6

Continuous Internal Evaluation:	
1	Journal should consist of 10 experiments.
2	Journal must include at least 2 assignments
3	Capstone/ Mini Project: End-to-end DL system: 1. Problem statement 2. Dataset collection 3. Preprocessing 4. Model development 5. Training 6. Evaluation 7. Deployment (optional) Use real-world dataset (e.g., Kaggle) Demonstrate automation and scalability
4	Total 25 Marks (Lab performance:10-marks, In-Semester Practical exam during Lab Session: 05 marks, Mini Project/Capstone Project: 05-marks, Attendance Theory & Practical: 05-marks.
Oral & Practical exam: Based on the above contents and entire syllabus of **DSPCC601 & DSPCL601**	

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Prac.	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					2
DSPCL602	**Software Engineering and Project Management Lab**	-	25	25	-	-	50	

Prerequisite : Computer Network and Programming Fundamentals	
Course Objectives: The course aims	
1	To understand DevOps practices which aims to simplify Software Development Life Cycle.
2	To be aware of different Version Control tools like GIT, CVS or Mercurial.
3	To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment.
4	To understand the importance of Jenkins to Build and deploy Software Applications on server environment
5	To use Docker to Build, ship and manage applications using containerization.
6	To understand the concept of Infrastructure as a code and install and configure Ansible tool
Course Outcomes: Learners will be able to	
1	Understand and use basic knowledge in software engineeriTo understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirementsng.
2	To obtain complete knowledge of the ―version control system‖ to effectively track changes augmented with Git and GitHub.
3	Understand the importance of Selenium and Jenkins to test Software Applications.
4	To understand the importance of Jenkins to Build and deploy Software Applications on server environment.
5	To understand concept of containerization and Analyze the Containerization of OS images and deployment of applications over Dockerk.
6	To Synthesize software configuration and provisioning using Ansible.

Suggested Experiments: Students are required to complete at least 10 experiments from the list given below.		
Sr. No.	**List of Experiments**	**CO Mapping**
1	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.	CO1
2	To understand Version Control System / Source Code Management, install git and create a GitHub account.	CO2
3	To Perform various GIT operations on local and Remote repositories using GIT Cheat-Sheet	CO2
4	To understand Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to setup a build Job	CO3
5	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat server.	CO4
6	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.	CO4
7	To Setup and Run Selenium Tests in Jenkins Using Maven.	CO3
8	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers	CO5
9	To learn Dockerfile instructions, build an image for a sample web application using Dockerfile.	CO5
10	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet	CO6
11	To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function)	CO6
12	To provision a LAMP/MEAN Stack using Puppet Manifest.	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)

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
DSPEL6011	Cloud & Computational Lab	-	25	-	-	-	25	

Note:	The **Cloud and Computational Lab** combine two program elective labs, with the **Cloud and Distributed Networks Lab** as the primary lab.

Prerequisite: Python programming	
Course Objectives: The course aims to	
1	To understand cloud computing concepts, virtualization technologies, distributed systems, and cloud service models (IaaS, PaaS, SaaS).
2	To acquire practical knowledge of distributed computing mechanisms, synchronization techniques, distributed snapshots, and NoSQL database deployment.
3	To analyze and model social networks using graph representations, network measures, link analysis, and community detection techniques
4	To develop recommendation systems using machine learning techniques, clustering, feature engineering, and ensemble approaches.
5	To implement Explainable Artificial Intelligence (XAI) techniques using modern tools such as SHAP, LIME, AIX360, and Integrated Gradients.
6	To design and evaluate intelligent systems with emphasis on interpretability, ethical AI, decision-making, and real-world applications.
Course Outcomes: Learners will be able to	
Cloud and Distributed Networks Lab	
1	Examine cloud computing service models and demonstrate the implementation of virtualization techniques to address real-world computing challenges.
2	Implement distributed algorithms for coordination and synchronization.
3	Understand and implement distributed processing frameworks like MapReduce and Spark.
Social Network Analytics Lab	
4	Analyze and characterize networks using visualization techniques.

5	Implement and evaluate network algorithms including PageRank, HITS, community detection, link prediction, and anomaly detection
6	Apply social network analysis concepts to real-world datasets to derive insights on network behavior.
Recommendation System Lab	
7	Understand mathematics and representation of data for recommendation systems.
8	Design, implement and analyze recommendation systems.
9	Understanding feature engineering and pre-processing for recommendation systems.
Explainable AI Lab	
10	Enhance transparency visualized through heatmaps (Grad-CAM) or feature -attribution tools (SHAP/LIME) and using the Saliency library
11	Build trust & adoption in safety critical areas like healthcare, finance and manufacturing.
12	Evaluate the Black box tendency of machine learning in decision making and human errors in decision making.

Sr. No.	Suggested List of Experiments	CO Mapping
Cloud and Distributed Networks Lab		
1	To study and Implement IAAS, PAAS, SAAS using AWS/Microsoft Azure.	CO1
2	A. Concept of Virtualization along with their types, structures and mechanisms. B. Demonstration of creating and running Virtual machines inside hosted hypervisors like Virtual Box and KVM	CO1
3	Clock Synchronization / Logical Clocks: Implement Lamport timestamps and vector clocks; simulate ordering of events	CO2
4	Distributed Snapshot / Global State: Implement Chandy-Lamport snapshot algorithm in a small, distributed simulation.	CO2
5	Installation and Setup of Apache Cassandra Install and configure a single-node and multi-node Cassandra cluster (manually or via Docker). Understand YAML configurations, cluster name, seeds, and snitches.	CO3

Social Network Analytics Lab		
1	Study on Types of networks, Network representation, Network properties –homophily, transitivity, reciprocity, degree distribution, Network	CO4

	visualization.	
2	Implement PageRank / HITS algorithm for Link analysis.	CO5
3	Implement community detection algorithm.	CO5
4	Calculate Centrality measures – degree centrality, closeness centrality, betweenness centrality, eigenvector centrality. Local and global clustering coefficient. Network density, path length, and diameter.	CO4
5	Study of link-based prediction approaches.	CO5
6	Implement Anomaly detection in social networks.	CO5
7	Case Study on applications on Social Network Analysis.	CO6

Recommendation System Lab		
1	Implementation of Matrix operations and data representation towards understanding mathematics for recommendation system	CO7
2	Experiment on the role of clustering methods with respect to recommendation systems.	CO7,CO9
3	Feature engineering and pre-processing of data for recommendation systems.	CO9
4	Implementation of Bayes classifier for recommendation.	CO8
5	Implementation of a recommendation system using Hybrid approach.	CO8
6	Implementation of a recommendation system using Ensembled approach.	CO8

Explainable AI Lab		
1	Implement Explainable AI decision trees and show the output for the following 1. Read the data set and split the data into features and a target value 2. Create a decision tree classifier 3. Train the model, measure its accuracy and save the mode. 4. Display the decision tree 5. Explain the structure of a decision tree and the decision process (XAI) ethics and bias in a model.	CO12
2	Implement a model -agnostic Kernel Explainer and the Tree Explainer to explain several different regression models - Linear regression, Decision tree regressor, Random Forest and Neural Network trained on a small diabetes data set.	CO11

3	Implement K-Nearest Neighbour (KNN) using Explainable AI(XAI) for mental health Diagnosis (COVID-19), Diagnosis based on the symptoms. Display the model's output and provide explanations.	CO11
4	Classify an image using a machine learning model and explain the classification using the integrated Gradients (IG) Use 1. Baseline image for comparison 2. White baseline or noise baseline 3. Computing integrated Gradient using the Saliency library.	CO12
5	Implement a linear logistic regression sentiment analysis model using SHAP. Use IMDBdata set (Tabular data)	CO10
6	Implement Newsgroups text classification with LIME, perform the following: 1 Vectorizing 2. AutoML Experiment-Random Forest Bagging, Gradient boosting, Decision tree and Extra trees use Data set http://qwone.com/20Newsgroups/	CO10

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	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
DSPEL 6012	Computational Intelligence Lab	-	25	-	-	-	25	

Note:	The **Computational Intelligence Lab** combine two program elective labs, with the **Embedded System and IoT Lab** as the primary lab.

Prerequisite: Python programming	
Course Objectives: The course aims	
1	To provide practical knowledge of IoT hardware components, embedded systems, sensor interfacing, communication protocols, and cloud-based IoT platforms.
2	To develop skills in data acquisition, data logging, visualization, and real-time communication using IoT technologies.
3	To understand social network structures, graph analytics, network measures, link analysis, and community detection techniques.
4	To apply machine learning, statistical analysis, and recommendation techniques for extracting insights and building intelligent systems.
5	To implement Explainable Artificial Intelligence (XAI) techniques using modern frameworks such as SHAP, LIME, AIX360, and Integrated Gradients.
6	To design, evaluate, and deploy intelligent and interpretable systems for real-world applications while considering ethics, bias, and societal impact.
Course Outcomes: Learners will be able to	
Embedded System and IoT Lab	
1	Implement basic embedded system operations using sensors, actuators, and microcontrollers.
2	Connect IoT devices with cloud platforms for data collection and visualization.
3	Apply IoT communication and messaging protocols such as MQTT, CoAP, and HTTP.
Social Network Analytics Lab	
4	Analyze and characterize networks using visualization techniques.
5	Implement and evaluate network algorithms including PageRank, HITS, community detection, link prediction, and anomaly detection

6	Apply social network analysis concepts to real-world datasets to derive insights on network behavior.
Recommendation System Lab	
7	Understand mathematics and representation of data for recommendation systems.
8	Design, implement and analyze recommendation systems.
9	Understanding feature engineering and pre-processing for recommendation systems.
Explainable AI Lab	
10	Enhance transparency visualized through heatmaps (Grad-CAM) or feature -attribution tools (SHAP/LIME) and using the Saliency library
11	Build trust & adoption in safety critical areas like healthcare, finance and manufacturing.
12	Evaluate the Black box tendency of machine learning in decision making and human errors in decision making.

Sr. No	**Suggested List of Experiments**	**CO Mapping**
Embedded System and IoT Lab		**CO**
1	Study of Embedded Hardware Components – Sensors, Actuators, and Microcontrollers	CO1
2	Interfacing Sensors (Temperature, Humidity, LDR) : To acquire sensor data through GPIO and analog pins.	CO1
3	Send Sensor Data to Cloud (ThingsBoard / ThingSpeak / AWS IoT Core): To visualize IoT data using dashboards.	CO2
4	Implement Data Logging and Visualization using Python: To perform real-time data analytics and visualization.	CO2
5	Implement MQTT Protocol for IoT Communication	CO3
6	Study and Implement CoAP or HTTP Protocol for IoT Communication	CO3

Social Network Analytics Lab		
1	Study on Types of networks, Network representation, Network properties – homophily, transitivity, reciprocity, degree distribution, Network visualization.	CO4
2	Implement PageRank / HITS algorithm for Link analysis.	CO5
3	Implement community detection algorithm.	CO5
4	Calculate Centrality measures – degree centrality, closeness centrality,	CO4

	betweenness centrality, eigenvector centrality. Local and global clustering coefficient. Network density, path length, and diameter.	
5	Study of link-based prediction approaches.	CO5
6	Implement Anomaly detection in social networks.	CO5
7	Case Study on applications on Social Network Analysis.	CO6

Recommendation System Lab		
1	Implementation of Matrix operations and data representation towards understanding mathematics for recommendation system	CO7
2	Experiment on the role of clustering methods with respect to recommendation systems.	CO7,CO9
3	Feature engineering and pre-processing of data for recommendation systems.	CO9
4	Implementation of Bayes classifier for recommendation.	CO8
5	Implementation of a recommendation system using Hybrid approach.	CO8
6	Implementation of a recommendation system using Ensembled approach.	CO8

Explainable AI Lab		
1	Implement Explainable AI decision trees and show the output for the following 1. Read the data set and split the data into features and a target value 2. Create a decision tree classifier 3. Train the model, measure its accuracy and save the mode. 4. Display the decision tree 5. Explain the structure of a decision tree and the decision process (XAI) ethics and bias in a model.	CO12
2	Implement a model -agnostic Kernel Explainer and the Tree Explainer to explain several different regression models - Linear regression, Decision tree regressor, Random Forest and Neural Network trained on a small diabetes data set.	CO11
3	Implement K-Nearest Neighbour (KNN) using Explainable AI(XAI) for mental health Diagnosis (COVID-19), Diagnosis based on the symptoms. Display the model's output and provide explanations.	CO11
4	Classify an image using a machine learning model and explain the classification using the integrated Gradients (IG) Use 1. Baseline image for comparison	CO12

	2. White baseline or noise baseline 3. Computing integrated Gradient using the Saliency library.	
5	Implement a linear logistic regression sentiment analysis model using SHAP. Use IMDBdata set (Tabular data)	CO10
6	Implement Newsgroups text classification with LIME, perform the following: 1 Vectorizing 2. AutoML Experiment-Random Forest Bagging, Gradient boosting, Decision tree and Extra trees use Data set http://qwone.com/20Newsgroups/	CO10

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	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
DSPEL 6013	Computational & Data Science Lab	-	25	-	-	-	25	

Note:	The **Computational & Data Science Lab** combine two program elective labs, with the **Graph Data Science Lab** as the primary lab.

Prerequisite: Python programming	
Course Objectives: The course aims	
1	To provide hands-on experience in graph database technologies, graph modeling, querying, administration, and graph-based data management.
2	To develop the ability to analyze complex networks using graph representations, network metrics, link analysis, community detection, and visualization techniques.
3	To apply machine learning and recommendation techniques for data analysis, prediction, classification, and intelligent decision-making.
4	To develop skills in feature engineering, statistical analysis, and advanced data processing for recommendation and predictive systems.
5	To implement Explainable Artificial Intelligence (XAI) methods using modern frameworks such as SHAP, LIME, AIX360, Integrated Gradients, and model-agnostic explainers.
6	To design, evaluate, and deploy interpretable intelligent systems for real-world applications while considering ethics, fairness, and societal impact.
Course Outcomes: Learners will be able to	
Graph Data Science Lab	
1	Comprehensive understanding of graph databases and their benefits
2	Proficiency in creating data models for representing complex relationships
3	Ability to write efficient queries and analyze graph data in administering and managing graph database
Social Network Analytics Lab	

4	Analyze and characterize networks using visualization techniques.
5	Implement and evaluate network algorithms including PageRank, HITS, community detection, link prediction, and anomaly detection
6	Apply social network analysis concepts to real-world datasets to derive insights on network behavior.
Recommendation System Lab	
7	Understand mathematics and representation of data for recommendation systems.
8	Design, implement and analyze recommendation systems.
9	Understanding feature engineering and pre-processing for recommendation systems.
Explainable AI Lab	
10	Enhance transparency visualized through heatmaps (Grad-CAM) or feature -attribution tools (SHAP/LIME) and using the Saliency library
11	Build trust & adoption in safety critical areas like healthcare, finance and manufacturing.
12	Evaluate the Black box tendency of machine learning in decision making and human errors in decision making.

Sr.No	**Suggested List of Experiments**	**CO Mapping**
Graph Data Science Lab		
1	Install and set up a graph database (e.g., Neo4j) and explore the environment and tools.	CO1
2	Design and implement a labeled property graph model and populate it with sample data.	CO2
3	Perform basic Cypher queries for nodes, relationships, and paths.	CO3
4	Execute advanced Cypher queries (subgraph matching, aggregation, and query optimization).	CO3
5	Perform administration tasks such as backup, restore, and access control.	CO3

Social Network Analytics Lab		
1	Study on Types of networks, Network representation, Network properties – homophily, transitivity, reciprocity, degree distribution, Network visualization.	CO4
2	Implement PageRank / HITS algorithm for Link analysis.	CO5
3	Implement community detection algorithm.	CO5

4	Calculate Centrality measures – degree centrality, closeness centrality, betweenness centrality, eigenvector centrality. Local and global clustering coefficient. Network density, path length, and diameter.	CO4
5	Study of link-based prediction approaches.	CO5
6	Implement Anomaly detection in social networks.	CO5
7	Case Study on applications on Social Network Analysis.	CO6

Recommendation System Lab		
1	Implementation of Matrix operations and data representation towards understanding mathematics for recommendation system	CO7
2	Experiment on the role of clustering methods with respect to recommendation systems.	CO7,CO9
3	Feature engineering and pre-processing of data for recommendation systems.	CO9
4	Implementation of Bayes classifier for recommendation.	CO8
5	Implementation of a recommendation system using Hybrid approach.	CO8
6	Implementation of a recommendation system using Ensembled approach.	CO8

Explainable AI Lab		
1	Implement Explainable AI decision trees and show the output for the following 1. Read the data set and split the data into features and a target value 2. Create a decision tree classifier 3. Train the model, measure its accuracy and save the mode. 4. Display the decision tree 5. Explain the structure of a decision tree and the decision process (XAI) ethics and bias in a model.	CO12
2	Implement a model -agnostic Kernel Explainer and the Tree Explainer to explain several different regression models - Linear regression, Decision tree regressor, Random Forest and Neural Network trained on a small diabetes data set.	CO11
3	Implement K-Nearest Neighbour (KNN) using Explainable AI(XAI) for mental health Diagnosis (COVID-19), Diagnosis based on the symptoms. Display the model's output and provide explanations.	CO11
4	Classify an image using a machine learning model and explain the classification using the integrated Gradients (IG) Use 1. Baseline image for comparison 2. White baseline or noise baseline	CO12

	3. Computing integrated Gradient using the Saliency library.	
5	Implement a linear logistic regression sentiment analysis model using SHAP. Use IMDBdata set (Tabular data)	CO10
6	Implement Newsgroups text classification with LIME, perform the following: 1 Vectorizing 2. AutoML Experiment-Random Forest Bagging, Gradient boosting, Decision tree and Extra trees use Data set http://qwone.com/20Newsgroups/	CO10

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
CEMDML 601	Big Data Computing Lab	-	25	25	-	-	50	

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 textbook)	CO5,CO6

Continuous Internal Evaluation (25 Marks)

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

Oral & Practical Exam (25 Marks)

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

Useful Links:

1. https://www.coursera.org/learn/hadoop#syllabus
2. https://www.coursera.org/learn/introduction-mongodb#syllabus
3. https://www.coursera.org/learn/data-visualization- tableau?specialization=data-visualization#syllabus
4. https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop#syllabus

Course Code	Course Name	Examination Scheme						Practical
		Marks Distribution			Exam Duration (Hrs)		Total Marks	2 Hrs
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ETMDML 601	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

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

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

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
ARMDML601	ROBOTICS Lab	-	25	25	-	-	50	

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

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Robot Components and Configuration: Understanding robot types, configurations, and components. using educational robotic arm, open Ware robotic simulator. Procedure: Identify the components of a robot. Classify robots based on their configuration. Observe actuators, sensors, and controllers. Results: Document robot types and components.	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.	CO2

	Results: Record transformed coordinates.	
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

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 Hours
		Internal Assessment		Oral & Practical	MSE	ESE		Total Credits
		Mid Sem Exam (MSE)	Continuous Internal Evaluation (CIE)					1
ITMDML 601	Microcontrollers Lab	-	25	-	-	-	25	

Course Objectives: The course aims to	
1	Impart assembly programming of PIC microcontroller
2	Impart assembly programming for I/O interface and timer, counter
3	Impart knowledge of 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	CO1

	2. LED inter facing 3. Blinking LED 4. Serial port programming 5. Counter programming	
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						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	-	-	50	

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

Suggested List of Experiments

Sr. No.	List of Experiments	CO Mapping
01	Study and demonstration of single-plate and multi-plate clutch mechanisms.	CO1
02	Comparative study of manual (synchromesh) and automatic transmission (torque converter / CVT).	CO1

03	Study and demonstration of propeller shaft, universal joint, and differential gear using cut section models.	CO2
04	Demonstration of suspension systems.	CO3
05	Analysis of chassis frames (ladder, monocoque, space-frame) and vehicle layout identification.	CO4
06	Study of EV architecture – components like battery, motor, inverter, and charging systems.	CO6

Continuous Internal Evaluation (25 Marks)

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

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
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

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)					2
DSCEP	Mini-Project-II	-	25	25	-	-	50	

Course Objectives: The course aims	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork among group members and inculcate the process of self-learning and research.
Course Outcomes: Learners will be able to	
1	Identify and define engineering or research problems addressing societal and technological needs.
2	Apply theoretical knowledge and practical skills to design, implement, and analyze solutions through experimentation or simulation.
3	Collaborate effectively in teams, demonstrating leadership, interpersonal, and communication skills.
4	Evaluate results and proposed solutions considering societal, ethical, and environmental implications for sustainable development.
5	Adhere to standard engineering norms and professional practices while managing project activities.
6	Engage in self-directed and lifelong learning, applying project management principles to continuous improvement and innovation.

Guidelines for Mini Project-II	
Sr. No.	**List of Experiments**
1	The mini project may involve product or prototype development, setup fabrication, experiment or process development, simulation, software or hardware integration, data analysis, or social/environmental awareness activities.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be

	allowed less than three or more than four students, as it is a group activity.
3	Students should conduct a survey to identify needs and formulate a problem statement for the mini project in consultation with the faculty supervisor or the Head of Department/internal faculty committee.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate..
8	The solution should be validated with proper justification, and the report must be compiled in the standard format prescribed by the University of Mumbai. Supporting documents such as Software Requirement Specification (SRS), research papers, or competition certificates may be included as annexures to the report.
9	To promote self-learning, innovation, and entrepreneurship, students should continue a single quality project over two semesters, with Mini Project–2 in Semester VI.
10	However, based on the individual students or group capability, with the mentor‘s recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in next semester. This policy can be adopted on a case by case basis.

Continuous Internal Evaluation (CIE)		
The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester		
In continuous assessment focus shall also be on each individual student, assessment based on individual‘s contribution in group activity, their understanding and response to questions.		
Distribution of Term work marks for a semester shall be as below:		**Marks 25**
1.	Marks awarded by guide/supervisor based on logbook	10
2.	Marks awarded by review committee	10
3.	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines	
Semester VI Mini-project -II:	
1.	**In this case in one semester students' group shall complete project in all aspects including**, Identification of need/problem Proposed final solution Procurement of components/systems Building prototype and testing
2.	**Two reviews will be conducted for continuous assessment** First shall be for finalization of problem and proposed solution Second shall be for implementation and testing of solution.
Mini Project shall be assessed based on following points:	
1.	Clarity of problem and quality of literature Survey for problem identification
2.	Requirement Gathering via SRS/ Feasibility Study
3.	Completeness of methodology implemented
4.	Design, Analysis and Further Plan
5.	Novelty, Originality or Innovativeness of project
6.	Societal / Research impact
7.	Effective use of skill set : Standard engineering practices and Project management standard
8.	Contribution of an individual's as member or leader
9.	Clarity in written and oral communication
10.	Verification and validation of the solution/ Test Cases
11.	Full functioning of working model as per stated requirements
12.	Technical writing /competition/hackathon outcome being met
In case of half year projects (completing in VI sem) all criteria in generic may be considered for evaluation of performance of students in mini projects.	

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1.	Report should be prepared as per the guidelines issued by the Mini Project-2 shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
2.	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

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