



Muthoot
Institute of Technology & Science
Autonomous
RELENTLESS PASSION FOR EXCELLENCE



M. TECH
ARTIFICIAL INTELLIGENCE & DATA SCIENCE
CURRICULUM & SYLLABUS
SEMESTER 1
2025 REGULATION

M.Tech

in

**ARTIFICIAL INTELLIGENCE
AND
DATA SCIENCE**

2025 REGULATION

CURRICULUM & SYLLABUS

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SEMESTER I

CURRICULUM

SLOT	COURSE CATEGORY	COURSE CODE	COURSE NAME	L	T	J	P	SS	C
A	Discipline Core	M250902/CN100A	ADVANCED MACHINE LEARNING	4	0	0	0	2	3
B	Programme Core	M250101/MA100B	MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE	3	0	0	0	3	3
C	Programme Core	M250101/AD100C	INTRODUCTION TO AI AND NLP	3	0	0	0	2	3
D	Programme Elective	M250101/AD11*D	PROGRAM ELECTIVE 1	3	0	0	0	2	3
E	Programme Elective	M250101/AD12*E	PROGRAM ELECTIVE 2	3	0	0	0	2	3
G	Research Core	M250902/CN100S	RESEARCH METHODOLOGY AND IPR	2	0	0	0	2	2
T	Laboratory	M250101/AD130T	ADVANCED MACHINE LEARNING LAB	0	0	0	2	2	1
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work, C- Credit)</i>									

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	4-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code		Course Name				Course Category	
M250902/CN100A		ADVANCED MACHINE LEARNING				DC	

COURSE OBJECTIVES	
1	To introduce supervised, unsupervised and reinforcement learning
2	To familiarize students with basic parameter estimation methods and Gradient Descent Algorithm
3	To enable students to identify and apply suitable machine learning algorithms for classification and regression
4	To equip students to compare and evaluate the performance of machine learning algorithms.
5	To familiarize students with machine learning based solutions for real world problems.

COMPETENCY STATEMENT	
CC 1	Demonstrate foundational understanding of machine learning paradigms and apply parameter estimation techniques and optimization algorithms such as Gradient Descent to solve classification and regression problems.
CC 2	Evaluate and compare the performance of machine learning algorithms using appropriate metrics, and design ML-based solutions to address real-world problems across multiple domains.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	Competency Mapping	Cognitive (C)
CO 1	Apply the Machine Learning concepts and basic parameter estimation methods for the solution of problems of different domains.	CC1	A
CO 2	Use regression and classification techniques to build models for real world scenarios.	CC1	A
CO 3	Apply unsupervised learning algorithms and dimensionality reduction techniques to analyse and interpret complex datasets for pattern discovery and feature extraction.	CC1	A
CO 4	Implement Support Vector Machine algorithms and graphical modelling techniques to solve real world problems.	CC1	A
CO 5	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance.	CC2	A
CO 6	Design, implement and analyse machine learning solution for a real-world problem.	CC2	C
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	2	2	2	2	-
2	2	-	2	2	2	2	-
3	3	-	3	2	3	2	-
4	3	-	3	2	3	2	-
5	3	-	3	2	3	2	-
6	3	3	3	2	3	2	3

Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical		Total	
4	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Parameter Estimation and Regression	MLE), Maximum a Posteriori Estimation (MAP) Gradient Descent Algorithm, Regression	8
2	Regularization techniques and Classification algorithms	linear and non-linear algorithms	9
3	Unsupervised learning	K-means, Density-based spatial clustering	8
4	Support Vector Machine and Graphical Models	SVM, Bayesian networks, Hidden Markov model	7
5	Evaluation Metrics and Sampling Methods	Metrics for classification, clustering, Resampling methods	8

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro project/Course based project	20
2	Regularization Techniques, Graphical Models, Gaussian mixture models	6
3	Seminar	4

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy.	MIT Press 2012.
2	Introduction to Machine Learning, 2nd edition	Ethem Alpaydin	MIT Press 2010.
Reference			
Sl. No.	Title of Book	Author	Publication
1	Data Mining Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei.	Third Edition. Morgan Kaufmann

2	Deep Learning	Goodfellow, I., Bengio, Y., and Courville, A.,	MIT Press, 2016.
3	Pattern recognition and machine learning.	Christopher M. Bishop.	Springer 2006
Web Resource			
1	Introduction to Machine Learning	Prof. Balaraman Ravindran	NPTEL IIT Madras
2	Machine Learning and Deep Learning - Fundamentals and Applications	Prof. M. K. Bhuyan	NPTEL IIT Guwahati

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Overview of machine learning: supervised, semi-supervised, unsupervised learning, reinforcement learning.	L	CO1	U	1
	Basics of parameter estimation: Maximum Likelihood Estimation (MLE)	L	CO1	U	1
	Basics of parameter estimation: Maximum Likelihood Estimation (MLE) – Examples	L	CO1	A	1
	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP)	L	CO1	A	1
	Basics of parameter estimation: Maximum a Posteriori Estimation (MAP) – Example	L	CO1	A	1
	Gradient Descent Algorithm, Batch Gradient Descent, Stochastic Gradient Descent	L	CO1	U	1
	Regression algorithms: least squares linear regression, normal equations and closed form solution	L	CO2	A	1
	Polynomial regression	L	CO2	A	1
2	Regularization techniques - LASSO and RIDGE	SS	CO2	U	1
	Classification algorithms: linear and non-linear algorithms	L	CO2	U	1
	Perceptron	L	CO2	A	1
	Logistic regression	L	CO2	A	1
	Naive Bayes	L	CO2	A	1
	Decision trees	L	CO2	A	1
	Neural networks: Concept of Artificial neuron	L	CO2	A	1
	Feed-Forward Neural Network	L	CO2	U	1
Back propagation algorithm	L	CO2	A	1	
3	Unsupervised learning: clustering, k-means	L	CO3	U	1
	Hierarchical clustering	L	CO3	A	1
	Principal component analysis	L	CO3	A	1
	Density-based spatial clustering of applications with noise (DBSCAN)	L	CO3	A	1
	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	SS	CO3	U	1

	Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model	SS	CO3	A	1
	Unsupervised learning: clustering, k-means	L	CO3	A	1
	Hierarchical clustering	L	CO3	A	1
4	Support vector machines and kernels: Max margin classification	L	CO4	U	1
	Support vector machines: Max margin classification	L	CO4	A	1
	Nonlinear SVM and the kernel trick, nonlinear decision boundaries	L	CO4	A	1
	Kernel functions	L	CO4	U	1
	Basics of graphical models - Bayesian networks	SS	CO4	U	1
	Hidden Markov model - Inference and estimation	SS	CO4	U	1
	Hidden Markov model - Inference and estimation	SS	CO4	A	1
5	Classification Performance Evaluation Metrics: Accuracy, Precision, Precision, Recall, Specificity, False Positive Rate (FPR), F1 Score, Receiver Operator Characteristic (ROC) Curve, AUC	L	CO5,CO6	A	1
	Regression Performance Evaluation Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination	L	CO5,CO6	A	1
	Clustering Performance Evaluation Metrics: Purity, Jaccard index, Normalized Mutual Information, Clustering Accuracy, Silhouette Coefficient, Dunn's Index	L	CO5,CO6	A	1
	Boosting: AdaBoost, gradient boosting machines.	L	CO5,CO6	U	1
	Resampling methods: cross-validation, bootstrap.	L	CO5,CO6	U	1
	Ensemble methods: bagging, boosting, random forests	L	CO5,CO6	U	1
	Practical aspects in machine learning: data preprocessing, overfitting, accuracy estimation, parameter and model selection	L	CO5,CO6	U	1
	Bias-Variance tradeoff	L	CO5,CO6	U	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Parameter Estimation and Regression	8		✓	✓				12
2	Regularization techniques and Classification algorithms	9		✓	✓				12
3	Unsupervised learning	8		✓	✓				12
4	Support Vector Machine and Graphical Models	7		✓	✓				12
5	Evaluation Metrics and Sampling Methods	8		✓	✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity	10
Internal Examination	10
Course Project	20
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-3	Version	25/0	Credits	3

(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)

Course Code	Course Name	Course Category
M250101/ MA100B	MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE	PC

COURSE OBJECTIVES

1	To develop fundamental knowledge in Linear algebra concepts like vector space, characteristics of matrices, projections, matrix decompositions which are useful in machine learning and data analysis problems.
2	To develop the skills required to implement the Linear Algebra concepts in PYTHON/MATLAB.
3	To introduce the challenges in applying the linear algebra and optimization concepts to real data sets and to implement them.

COMPETENCY STATEMENT

CC1	Demonstrate an ability in applying machine learning algorithms to model, analyse, and optimize data-driven models.
CC2	Demonstrate an ability to analyse and interpret matrix properties to determine solvability, stability, and conditioning of linear systems
CC3	Develops algorithmic and programming skills to implement linear algebra and optimization concepts in different machine learning problems.

COURSE OUTCOMES

Course Outcomes (CO): At the end of this course, learners will be able to:

CO	CO Statement	Competency Mapping	Cognitive (C)
CO 1	Apply gradient descent algorithm to fit regression models for different types of data sets.	CC1, CC3	A
CO 2	Apply the knowledge in linear algebra concepts towards the analysis, inference and prediction stages of data analytics.	CC2, CC3	A
CO 3	Apply eigen vectors and singular value decomposition (SVD) to extract structural information, reduce dimensionality, and assess stability of systems.	CC2, CC3	A
CO 4	Implement linear algebra concepts in scientific programming languages (MATLAB/Python).	CC3	A
CO 5	Design, Develop, implement, and present innovative ideas on the application of linear algebra for Data Science, Machine learning, and Artificial Intelligence.	CC1,CC2, CC3	C

Cognitive (Revised blooms Level): - **R:** Remember; **U:** Understand; **A:** Apply; **An:** Analyse; **E:** Evaluate; **C:** Create

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	1	1	2	2	-
2	2	-	1	1	2	2	-
3	2	-	1	1	2	2	-
4	2	-	1	1	2	2	-
5	2	2	2	2	2	2	2

Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week	Credit	Hours / Semester	Examination Scheme		
			Theory	Practical	Total

L	T	J	P	S	C		CIA	ESE	Total	CIA	ESE	Total	
3	0	0	0	3	3	90	40	60	100				100

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Hrs
1	Gradient descent and Regularization	Gradient descent for a linear regression algorithm, Gradient descent for polynomial regression, Normal equations.	8
2	Linear Algebra- Vectors and matrices	Vectors-Geometry and Algebra, Vector spaces, Subspaces, Matrices, Matrix zoology, Addition, Transpose, Shifting and Trace of a matrix, Coding Challenges.	7
3	Matrix Multiplication, Rank and Matrix spaces	Matrix multiplication- Different perspectives, Hadamard multiplication, Symmetric matrices, Asymmetry index, Rank-different concepts, Matrix spaces, Code challenges.	7
4	Determinants, Projections and orthogonalization	Determinants, Matrix inverse- Concept and applications, Left inverse, Right inverse and pseudo inverse, Projections in R^2 and R^n , Gram Schmidt procedure, QR decomposition, Least squares for model fitting, Applications, Code challenges.	10
5	Dimensionality Reduction: Eigen decomposition and Singular value decomposition	Eigen values, Eigen vectors, Diagonalisation, Matrix powers, Eigen layers, Eigen decomposition, Singular value decomposition, Symmetric matrices, Spectral theory of matrices, Condition number, SVD and matrix inverse, MP pseudo inverse, Code challenges.	8

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description.	Hrs
1	Applications of Linear Algebra in Data Science.	5
2	Regularization in Machine learning.	5
3	Algorithm to implement gradient descent for simple linear, multi linear and polynomial regression.	5
4	Practice problems on vectors	2
5	Programming Assignment on vectors	2
6	Practice problems on matrices and decompositions	3
7	Programming assignment on matrices	3
8	Micro project in machine learning/ Data analysis	25

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Linear Algebra: Theory, Intuition, Code	Mike X Cohen	Kindle edition
2	Linear Algebra and Optimization for Machine Learning	Charu C. Aggarwal	Springer 2020
Reference			
Sl. No.	Title of Book	Author	Publication
1	Matrix Computations	Gene H. Golub, Charles F. Van Loan	John Hopkins University Press
2	Data Science from Scratch: The #1 Data Science Guide for Everything A Data Scientist Needs to Know: Python, Linear Algebra, Statistics, Coding, Applications, Neural Networks, and Decision Tree	Steven Cooper	Kindle edition
3	Eigen Values and Eigen Vectors in Data Dimension Reduction for Regression	Randolf H. Reiss	San Marcos, Texas

4	Linear Algebra and its Applications	Gilbert Strang	Thomson Learning Inc
Web Resource			
1	https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/pages/syllabus/		
2	https://nptel.ac.in/courses/111107137		
3	https://nptel.ac.in/courses/111105165		

DETAILED SYLLABUS					
Module	Major Topic & Sub Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Gradient Descent, Intuitions,	L	1	A	1
	Gradient Descent for a Regression algorithm.	L	1	A	2
	Gradient Descent on Multiple Features,	L	1	A	2
	Practice on Gradient Descent	L	1	A	1
	Gradient Descent for Polynomial Regression	L	1	A	1
	Gradient Descent and Normal Equation	L	1	A	1
2	VECTORS: geometry and algebra, Vector addition, and subtraction, Vector-scalar multiplication,	L	2	U	1
	Dot product geometry, Vector orthogonality,	L	2	A	1
	Vector Hadamard multiplication, cross product, unit vectors, Coding	L	2 & 4	A	1
	VECTOR SPACES: Dimensions, and fields in linear algebra, Subspaces, Subspaces vs. subsets	L	2	A	1
	Span, Linear independence, Basis	L	2	A	1
	MATRICES:	L	2	U	1
	dimensionality, Matrix operations, Matrix-scalar multiplication,				
Complex matrices, Addition, equality, transpose, Diagonal, and trace,	L	2	U	1	
3	MATRIX MULTIPLICATION: matrix multiplication by layering, Multiplication with diagonals, Matrix-vector multiplication,	L	2	A	1
	Symmetric matrices, multiply symmetric matrices, Hadamard Multiplication, asymmetry Index, Code challenge,	L	2 & 4	A	1
	RANK-concepts, Maximum possible rank, Computing rank, Rank and scalar multiplication, Rank of added and multiplied matrices	L	2	A	1
	The rank of A & A ^T . A ^T A, AA ^T , random matrices,	L	2	A	1
	Boosting rank by shifting, rank difficulties, rank, and span, Code challenge:	L	2	A	1
	MATRIX SPACES: Column space and Row space of a matrix (A & AA ^T), Null space of a matrix,	L	2	A	1
	orthogonal subspaces, Dimensions of column/row/null spaces, Example of the four subspaces, code challenge,	L	2 & 4	A	1
4	DETERMINANT- Determinant of a 2x2 matrix, & 3x3 matrix, characteristic polynomial, the full procedure,	L	2	U	1

	Determinant of triangles, determinant and row reduction, determinant and scalar multiplication, theory vs practice, Code challenge	L	2 & 4	A	1
	MATRIX INVERSE: Concept and applications, Inverse of a Diagonal matrix, Inverse of a 2x2 matrix, The MCA algorithm to compute the inverse,	L	2	U	1
	Computing the inverse via row, Left inverse and right inverse, Pseudo- inverse, Code challenge	L	2 & 4	A	1
	Projections in R^2 , Projections in R^N , Orthogonal and parallel vector components,	L	2	A	1
	Orthogonal matrices, Gram-Schmidt procedure, QR decomposition,	L	2	A	1
	Inverse via QR Decomposition, Code challenge	L	2 & 4	A	1
	Introduction, least squares via left inverse, Least squares via orthogonal projection,	L	2	A	1
	Least squares via row-reduction, Model-predicted values, and residuals	L	2	A	1
	Least-squares applications, Code challenge	L	2 & 4	A	1
5	Eigenvalues, eigenvectors, Eigen decomposition,	L	3	A	1
	Diagonalization, Matrix powers via diagonalization	L	3	A	1
	Distinct and repeated eigenvalues, symmetric matrices, Eigen layers of a matrix,	L	3	A	1
	Eigen decomposition of singular matrices, Matrix powers and Inverse, Generalized eigen decomposition, Code challenges	L	3 & 4	A	1
	Singular value decomposition, Computing the SVD, singular values and eigenvalues,	L	3	A	1
	Symmetric Matrices, SVD and the four subspaces, SVD, and matrix rank,	L	3	A	1
	Spectral theory of matrices, SVD for low-rank approximations, Normalizing singular values, the Condition number of a matrix,	L	3	A	1
	SVD and Matrix Inverse, MP pseudo inverse, code challenges	L	3 & 4	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Gradient descent and Regularization	8		✓	✓				12

2	Linear Algebra- Vectors and matrices	7		✓	✓				12
3	Matrix Multiplication, Rank and Matrix spaces	7		✓	✓				12
4	Determinants, Projections and orthogonalization	10		✓	✓				12
5	Dimensionality Reduction: Eigen decomposition and Singular value decomposition	8		✓	✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Internal Examination	10
Learning Activity	10
Course Project	20
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD100C	INTRODUCTION TO AI AND NLP					PC	

COURSE OBJECTIVES	
1	Learn the application of AI in various important application domains
2	Learn to extract information from unstructured text and to apply different techniques for text analytics.
3	Implement and evaluate NLP applications using machine learning and deep learning methods.

COMPETENCY STATEMENTS	
CC1	Familiarise with various applications of AI, ML algorithms and computational tools used in the field of NLP
CC2	Analyse various NLP tasks through the lens of deep learning

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	Competency Mapping	Cognitive (C)
CO 1	Analyze the applications of AI in the domain of NLP	2	A
CO 2	Transform text into an appropriate data structure	2	A
CO 3	Apply Probability models, language models, and Markov models for Text processing	2	A
CO 4	Build NLP applications using Machine Learning Methods	2	A
CO 5	Design, Develop, Implement and Present innovative Ideas on NLP and AI	2	C
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	2	-	2	2	-
2	2	-	2	-	2	2	-
3	2	-	2	-	2	2	-
4	2	1	2	3	2	2	-
5	2	1	2	3	2	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”</i>							

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical		Total	
							CIA	ESE	Total	CIA	ESE		Total
3	0	0	0	30	70	3	40	60	100				100
L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination													

SYLLABUS (Major Topics)

Module	Title	Major Topics	Contact Hours
1	Introduction to AI	Types of AI, Application of AI in different real-world applications, AI tools and framework, NLP Pipe Line	7
2	Regular Expression and Text Processing	Types of regular expression and its use in NLP, Text processing, Language independent tokenization, string matching and spelling correction	7
3	Word Embedding & Probabilistic Models	Various word embedding techniques, Markov Models, Language Modelling, Cipher Decryption with Language Modelling, Article Spinning	8
4	NLP Using Machine Learning Models	Spam detection, semantic analysis, topic modelling, Latent semantic indexing	9
5	Deep Learning	CNN, Sequence modelling, RNN, LSTM, Attention, Transformers, Transfer learning	9

SELF-LEARNING / TEAM WORK

Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro project – building various NLP tasks like sentiment classifier, Text Summarizer, Q&A systems	20
2	Seminar	10

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Practical Natural Language Processing,	Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana	Shroff/O'Reilly, 2020.
2	Natural Language Processing Recipes Unlocking Text Data with Machine Learning and Deep Learning using Python,	Akshay Kulkarni, Adarsha Shivananda	Apress, 2019

Reference

Sl. No.	Title of Book	Author	Publication
1	Neural Network Models for Natural Language Processing,	Yoav Goldberg, Graeme Hirst.	Morgan and Claypool Life Sciences, 2017
2	Applied Natural Language Processing with Python- Implementing Machine Learning and Deep Learning Algorithms for Natural Language Processing	Taweh Beysolow II	Apress, 2018

Web Resource

1	Natural Language Processing in Deep Learning by Stanford	Coursera	
2	Deep Learning Specialization by	deeplearning.ai	
3	Applied AI with Deep Learning by IBM	Coursera	

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Artificial Intelligence? History, AI on a conceptual level, Types of AI, Use Cases, importance and applications of AI,	L	CO1	U	1
	AI algorithms, types of machine learning, types of problems solved in AI, advantages, and disadvantages of AI	L	CO1	U	1
	AI In Marketing, Banking, Finance, Agriculture, HealthCare, Gaming, Space Exploration, Autonomous Vehicles, Chatbots,	L	CO1	U	1
	Artificial Creativity, AI Tools & Frameworks, AI vs Machine Learning vs Deep Learning, an overview of python for AI,	L	CO1	U	1
	NLP in the Real World, NLP Tasks, Language? Its Building Blocks, Why Is NLP Challenging? Machine Learning, Deep Learning, and NLP: An Overview, Approaches to NLP, Heuristics-Based NLP, Machine Learning & Deep Learning for NLP	L	CO1	A	1
	NLP Pipeline, Applications of NLP-Machine translation, Speech recognition, Image Captioning, spam detection, text prediction-	L	CO1	A	1
2	Introduction to Software Packages-Spacy, NLTK, Gensim, PyTorch, Regular Expression- importance, properties, working and python package (re), case study: working of Eliza chatbot	L	CO1	A	1
	Common regex function used in NLP	L	CO2	U	1
	Meta Characters- Big brackets, cap, Backslash,	L	CO2	U	1
	Squared Brackets, Special Sequences, Asterisk, Plus, And Question mark, Curly Brackets	L	CO2	U	1
	Understanding Pattern Objects- Match Method Vs Search Method, Finditer Method, Logical Or, Beginning And End Patterns, Parenthesis	L	CO2	U	1
	String Modification- split method, sub-method, subn method,	L	CO2	U	1
	Words, Tokens, Counting words, vocabulary, corpus, tokenization in spacy-	L	CO2	A	1
	Sentiment Classification- (yelp) download a review dataset use -data preparation using NumPy, pandas, counter, re-add tokens to vocabulary, build vocabulary from a data frame, from corpus, one hot encoding, encoding documents, train test splits, feature computation, confusion matrix, analysis.	L	CO2	A	1
Language Independent Tokenization: Types of tokenization — Word, Character, and sub-word tokenization, problems with word tokenizer, drawbacks of a character- based tokenizer, problems with sub-word tokenization, Byte Pair Encoding	L	CO2	A	1	

	String Matching and Spelling Correction- Minimum edit distance- table filling, dynamic programming,	L	CO2	A	1
3	Vector Models & Text Preprocessing: Vectors, Bag of Words, Count Vectorizer, Tokenization, Stop words,	L	CO3	A	1
	Stemming and Lemmatization, Count Vectorizer, Vector Similarity. TF-IDF,	L	CO3	A	1
	Word-to-Index Mapping, Building TF-IDF	L	CO3	A	1
	Neural Word Embeddings, Neural Word Embeddings Demo. Vector Models & Text Pre-processing Summary, steps of a typical NLP analysis	L	CO3	A	1
	Language Modelling: types of language modelling, the importance of language modelling, the curse of dimensionality, Language Model Markov Assumption And N-Grams,	L	CO3	A	1
	Language Model Implementation – Setup, Ngrams Function, Update Counts Function, Probability Model Function, Reading Corpus, Language Model Implementation Sampling Text,	L	CO3	A	1
	Markov Models: Markov Property, Markov Model, Probability Smoothing and Log-Probabilities, Building a Text Classifier,	L	CO3	A	1
	Article Spinning–Problem Description, N-Gram Approach, implementation in python,	L	CO3	A	1
	Cipher Decryption with Language Modeling And Genetic Algorithm- Ciphers, substitution cipher, bigrams, maximum likelihood, and log-likelihood, Language models, Genetic Algorithms,	L	CO3	A	1
4	Spam Detection– Problem, Naive Bayes theorem, Intuition, spam detection using Naïve Bayes, class imbalance, ROC, AUC, AND F1 SCORE, Implementing spam detection in python,	L	CO4	A	1
	Sentiment Analysis -Problem, Logistic Regression Intuition, Multiclass Logistic Regression,	L	CO4	An	1
	Logistic Regression Training and Interpretation, sentiment analysis implementation in python	L	CO4	An	1
	Text Summarization-Using Vectors, Text Rank Intuition	L	CO4	A	1
	Text Rank in Python, Text Summarization in Python	L	CO4	A	1
	Topic Modelling-different topic modelling techniques, Latent Dirichlet Allocation (LDA) – Essentials, Latent Dirichlet Allocation– Topic Modelling with Latent Dirichlet	L	CO4	A	1
	Latent Symmatc Modelling (Indexing)-LSA / LSI Introduction, Singular Value Decomposition Intuition, LSA / LSI: Applying SVD to NLP, Latent Semantic Analysis / Latent Semantic Indexing in Python	L	CO4	An	1

5	word embeddings, nonlinear neural networks	L	CO5	U	1
	Neuron – Intro, Fitting a Line, Classification Code Preparation, Text Classification in Tensorflow, The Neuron, How does a model learn?	L	CO5	A	1
	Feed Forward Neural Networks- Ann-introduction, The Geometrical Picture, Activation Functions, Multiclass Classification, Text Classification ANN in Tensorflow,	L	CO5	A	1
	Text Preprocessing Code Preparation, Text Preprocessing in Tensorflow, Embeddings, CBOW(continuous bag of words), CBOW in Tensorflow	L	CO5	A	1
	CONVOLUTION NEURAL NETWORKS:- CNN-Introduction, Convolution, pattern matching, weight sharing, convolution in color images,	L	CO5	U	1
	Convolution Neural Networks- Convolution, pattern matching, weight sharing, convolution in color images, CNN Architecture, CNN for Text, CNN for NLP in Tensorflow,	L	CO5	A	1
	Recurrent Neural Networks- Simple RNN / Elman Unit, RNNs: Paying Attention to Shapes, GRU, and LSTM. RNN for Text Classification in TensorFlow,	L	CO5	A	1
	Parts-of-Speech Tagging, and Named Entity Recognition in TensorFlow	L	CO5	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Introduction to AI	7		✓	✓				12
2	Regular Expression and Text Processing	7		✓	✓				12
3	Word Embedding & Probabilistic Models	8			✓				12
4	NLP Using Machine Learning Models	9			✓	✓			12
5	Deep Learning	9			✓			✓	12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity	10
Internal Examination	10

Course Project	20
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD111D	DATA ANALYTICS					PE 1	

COURSE OBJECTIVES	
1	To impart foundational knowledge of data representation, relations, and dependencies for effective pre-processing and error handling in analytics.
2	To enable students to apply statistical and mathematical techniques such as correlation and hypothesis testing for deriving meaningful insights from data.
3	To familiarize learners with core data analytics methods including regression, classification, clustering, and dimensionality reduction for solving real-world problems.
4	To develop proficiency in visualization and analytical tools (with emphasis on R) for exploring, interpreting, and presenting data effectively.
5	To cultivate the ability to design and implement scalable applications that integrate advanced analytics and parallelization techniques for real-time data analysis.

COMPETENCY STATEMENTS	
CC1	Ability to pre-process, analyze, and interpret data using statistical and machine learning techniques to identify patterns, dependencies, and errors for informed decision-making.
CC2	Ability to design and implement scalable data-driven applications by applying data visualization, finite state modelling, and parallelization concepts, to enable effective real-time analytics.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Identify data errors and dependencies among attributes by modelling them as sets & relations.	CC1	A
CO 2	Apply statistical methods for evaluation hypothesis	CC1	A
CO 3	Apply regression, classification, and clustering models on a given dataset	CC2	A
CO 4	Apply correlation techniques to find the dependencies between the features.	CC1	A
CO 5	Develop applications that uses the concepts in Data Analytics	CC2	C
Cognitive (Revised blooms Level): - <i>R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create</i>			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	2	1	3	1	-
2	3	-	2	1	3	1	-
3	2	-	3	1	3	1	-
4	2	-	2	1	3	1	-
5	2	2	3	3	3	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
							CIA	ESE	Total	CIA	ESE	Total	
3	0	0	0	30	70	3	40	60	100				100

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Data and Relations	Data and Relations, Data Pre-processing, Correlation	7
2	Data Analytics	Basic Data Analytics Methods Using R, Visualization methods using R	9
3	Models	AR, MA Models	6
4	Clustering	Clustering, Regression	7
5	Classification Methods	Classification Methods, Scalability through parallelization	11

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project – Data interpretation	14
2	Review article	14
3	Attributes and Data Types	2

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Data Analytics - Models and Algorithms for Intelligent Data Analysis	Thomas A. Runkler	Springer 2012.
2	Big Data Analysis for Large-Scale Multimedia Search	Stefanos Vrochidis, Benoit Huet, Edward Chang, Ioannis Kompatsiaris,	Wiley 2019.
Reference			
Sl. No.	Title of Book	Author	Publication
1	A General Introduction to Data Analytics	J. O. Moreira, Andre Carvalho, Tomas Horvath,	Wiley 2019.
2	Feature Engineering For Machine Learning and Data Analytics	Gouzhu Dong and Huan Liu	CRC Press.
Web Resource			
1	https://www.youtube.com/watch?v=F_x5a4OJGrU&t=2s		NPTTEL
2	https://www.youtube.com/watch?v=NFys6AObPhM		NPTTEL

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Data scales, Set and Matrix representations	L	CO1	U	1
	Relations, Similarity and dissimilarity measures	L	CO1	A	1
	Sequence relations.	L	CO1	U	1
	Data pre-processing - Error types, error handling, Filtering	L	CO1	An	1
	Transformation, merging	L	CO1	A	1
	Correlation-Linear, Causality Chi-Square tests	L	CO4	A	1
	Cross validation and feature selection	L	CO1	A	1
2	Introduction to R and GUI	L	CO2	A	1
	Attributes and Data Types	SS	CO2	U	1
	Descriptive Statistics	L	CO2	U	1
	Statistical methods for evaluation and Hypothesis	L	CO2	A	1
	Hypothesis Testing- Difference of Means	L	CO2	An	1
	Type -I, Type -II Errors, Problems	L	CO2	A	1
	ANNOVA	L	CO2	A	1
	Visualization – Single variable.	L	CO2	A	1
3	Examining multiple variables	L	CO2	An	1
	Finite state machines	L	CO3	U	1
	Recurrent models	L	CO3	U	1
	Autoregressive models	L	CO3	U	1
	Autoregressive models	L	CO3	A	1
	Moving Average Models- ARIMA	L	CO3	A	1
4	Moving Average Models- ARMA 1	L	CO3	A	1
	Cluster partitions	L	CO3	A	1
	Sequential clustering, Prototype based clustering	L	CO3	A	1
	Relational clustering,	L	CO3	U	1
	Cluster tendency assessment, Cluster validity	L	CO3	U	1
	Self-organising map (SOP).	L	CO3	U	1
	Regression: Linear regression	L	CO4, CO3	A	1
5	Logistic Regression, Use cases	L	CO3	A	1
	Naive Bayes classifier	L	CO5	A	1
	LDA	L	CO5	U	1
	SVM	L	CO5	U	1
	Learning Vector Quantization	L	CO5	U	1
	Scalability through parallelization	L	CO5	A	1
	Data parallelization, Process parallelization	L	CO5	A	1
	Scaling using feature engineering	L	CO5	U	1
	Cascading, Feature reduction through spatial transforms	L	CO5	A	1
	ReLU nonlinearity	L	CO5	A	1
	Data Augmentation, MLP, Convolutional Layer	L	CO5	A	1
Global Average Pooling, Dimensionality Reduction	L	CO5	A	1	

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Data and Relations	7		✓	✓				12
2	Data Analytics	9		✓	✓				12
3	Models	6		✓	✓				12
4	Clustering	7		✓	✓				12
5	Classification Methods	11			✓	✓			12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD112D	R FOR DATA SCIENCE					PE 1	

COURSE OBJECTIVES	
1	To introduce the R programming environment and develop skills in data loading, organization, exploration, and cleaning for data science applications.
2	To enable learners to design, build, and evaluate machine learning and statistical models in R for prediction and analysis.
3	To train learners in effective documentation and data visualization techniques to communicate insights and apply R programming for solving real-world analytics problems.

COMPETENCY STATEMENTS	
CC1	Apply data science and machine learning techniques including data preparation, model design, prediction, and visualization to analyze real-world datasets and generate meaningful insights.
CC 2	Develop practical problem-solving skills using R programming by building, evaluating, and validating predictive models and effectively communicating results through visualizations and reports.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Organize, explore, clean, and analyze datasets to extract meaningful patterns and insights.	CC 1	A
CO 2	Design and implement machine learning models to generate accurate predictions from data.	CC 1	A
CO 3	Demonstrate data patterns effectively using appropriate data visualization techniques and packages.	CC 1	A
CO 4	Build, evaluate, and validate predictive models for different types of data to ensure reliability and performance.	CC1, CC2	A
CO 5	Apply R programming skills to address real-world data analytics problems through practical implementation.	CC 2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	1	2	2	2	-
2	2	-	2	3	3	3	-
3	3	-	2	3	3	3	-
4	3	-	3	3	3	3	-
5	3	3	3	3	3	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
							CIA	ESE	Total	CIA	ESE	Total	
3	0	0	0	30	70	3	40	60	100				100

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Introduction to R	Reading and getting data into R, Vectors and assignment, Logical and Index vectors, Generating regular sequences, Missing values, Ordered and Unordered Factors, The function tapply() and ragged arrays, Ordered factors.	9
2	Exploring and cleaning data for analysis	Reading data from files, Data organization, Arrays and Matrices, Basics of Arrays in R, Matrix operations, Advanced Matrix operations, Additional Matrix facilities, Lists and Data frames.	11
3	Building machine learning models	Building linear models, Generalized linear models, Nonlinear least squares and maximum likelihood models.	8
4	Evaluating and Validating models	Evaluating and Validating models, Probability distributions in R, Statistical models in R.	5
5	Data Visualization	Documentation, Graphical analysis, plot() function, Displaying multivariate data, Using graphics parameters, Matrix plots, Exporting graphs, ggplot package.	7

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	R data types and coercion rules.	1
2	Vectorized operations in R.	2
3	Best practices for data import (CSV, Excel, databases).	2
4	Reading data from multiple sources (CSV, JSON, databases, APIs).	1
5	Advanced matrix operations in R.	2
6	Data cleaning and preprocessing using dplyr	3
7	Organizing data using lists and data frames.	2
8	Logistic regression vs. linear regression.	2
9	Regularization methods	2
10	Cross-validation techniques in R.	2
11	ROC, AUC, confusion matrix for model evaluation.	2
12	Bias-variance tradeoff in machine learning.	1
13	Interactive visualization with plotly	2
14	Dashboard creation in R	3
15	Storytelling with data visualization.	3

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Practical Data Science with R	Nina Zumel, John Mount	Manning Publications, 2014.
2	An Introduction to R	W. N. Venables, D. M. Smith and the R Core Team	R Development Core Team Permission, 2013

Reference			
Sl. No.	Title of Book	Author	Publication
1	R Programming for Data Science	Roger D. Peng	Lean Publishing, 2015.
2	Visualize This: The Flowingdata Guide to Design, Visualization and Statistics	Nathan Yau	Wiley, 2011.
3	Mining of Massive Datasets	Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman	Cambridge University Press, 2014.
4	The Book of R - A First Course in R Programming and Statistics	Tilman M. Davies	No Starch Press, 2016.
5	Practical Data Science Cookbook	Tony Ojeda, Sean Patrick Murphy, Benjarnin Bengfort. Abhijit Dasgupta	Packt Publishing Limited, 2014.
Web Resource			
1	https://r4ds.had.co.nz		
2	https://arxiv.org/abs/2301.01188		
3	https://exploringr.princeton.edu/self-learning-resources-for-r		
4	https://swirlstats.com		
5	https://education.rstudio.com/learn/beginner		
6	https://posit.cloud/learn/primers		
7	https://github.com/rfordatascience/tidytuesday		

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Introduction to R environment, Installation of R environment and R studio.	L,Lab	1	A	1
	Variables and datatypes in R	L,Lab	1	A	1
	Reading and getting data into R	L,Lab	1	A	1
	Vectors and Assignment	L,Lab	1	A	1
	Logical and Index vectors	L,Lab	1	A	1
	Generating regular sequences	L,Lab	1	A	1
	Missing values, Ordered and Unordered Factors	L,Lab	1	A	1
	The function tapply() and ragged arrays	L,Lab	1	A	1
2	Ordered factors	L,Lab	1	A	1
	Reading data from files	L,Lab	2	A	1
	Data organization	L,Lab	2	A	1
	Arrays and Matrices	L,Lab	2	A	1
	Basics of Arrays in R	L,Lab	2	A	1
	Matrix operations	L,Lab	2	A	1
	Advanced Matrix operations	L,Lab	2	A	1
	Additional Matrix facilities	L,Lab	2	A	1
	Introduction to Lists	L,Lab	2	A	1
	Introduction to Lists	L,Lab	2	A	1
3	Data frames	L,Lab	2	A	1
	Data frames	L,Lab	2	A	1
	Building linear models	L,Lab	3	A	1
	Building linear models	L,Lab	3	A	1

	Generalized linear models	L,Lab	3	A	1
	Generalized linear models	L,Lab	3	A	1
	Nonlinear least squares	L,Lab	3	A	1
	Nonlinear least squares	L,Lab	3	A	1
	Maximum likelihood models	L,Lab	3	A	1
	Maximum likelihood models	L,Lab	3	A	1
4	Evaluating and Validating models	L,Lab	4	A	1
	Probability distributions in R	L,Lab	4	A	1
	Probability distributions in R	L,Lab	4	A	1
	Statistical models in R	L,Lab	4	A	1
	Statistical models in R	L,Lab	4	A	1
5	Graphical analysis, plot()	L,Lab	5	A	1
	Graphical analysis, plot()Displaying multivariate data	L,Lab	5	A	1
	Using graphics parameters	L,Lab	5	A	1
	Matrix plots	L,Lab	5	A	1
	Exporting graphs	L,Lab	5	A	1
	ggplot package	L,Lab	5	A	1
	Documentation	L,Lab	5	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Introduction to R	9			✓				12
2	Exploring and cleaning data for analysis	11			✓				12
3	Building machine learning models	8			✓				12
4	Evaluating and Validating models	5			✓				12
5	Data Visualization	7			✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity	15
Internal Examination	10
Course Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD113D	DATA VISUALIZATION WITH PYTHON					PE 1	

COURSE OBJECTIVES	
1	Learn basic concepts of Data Visualization
2	Learn visualization libraries in Python and apply them to obtain and understand the underlying information.
3	To implement visualization techniques to build an interactive board.

COMPETENCY STATEMENTS	
CC1	Evaluate the importance of data visualization in analytics, choose suitable tools, and apply effective visualization methods to derive meaningful insights from complex datasets.
CC2	Implement data visualization tasks using Python libraries and develop interactive dashboards using Plotly to communicate analytical findings effectively.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Analyze the need for data Visualization in Data Analytics	CC1	A
CO 2	Identify the right tool for Data Visualization based on the Data Analytics Problem	CC1	A
CO 3	Utilize the right visualization technique to obtain information, knowledge, and insight from a particular Dataset.	CC2	A
CO 4	Implement Visualization tasks using Python	CC1	A
CO 5	Apply Plotly to create plots like Bar Charts, Line Charts, Scatter Plots, and Heat Maps, and create and deploy an interactive dashboard	CC2	AppAly

Cognitive (Revised blooms Level): - **R:** Remember; **U:** Understand; **A:** Apply; **An:** Analyse; **E:** Evaluate; **C:** Create

CO	Program Outcomes PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	3	2	2	2	2	2	-
2	2	-	2	-	3	2	-
3	3	2	-	3	-	2	-
4	-	1	3	-	3	1	-
5	3	2	-	3	-	2	2

Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	
							40	60	100				

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)

Module	Title	Major Topics	Contact Hours
1	Python Visualization Charts and Introduction to Numpy and Pandas	Data visualization using Numpy and Pandas	8
2	Pandas	Data Visualisation With Pandas, Series, and Columns, Indexing And Sorting, Filtering Data Frames	8
3	Pandas & Matplotlib	Updating values, Working With Types, Matplotlib, Pandas Plotting	8
4	Pandas & Seaborn	Pandas, Seaborn, Seaborn Categorical Plots, Controlling Seaborn Aesthetics	6
5	Python dashboards with Plotly and Dash	Introduction to Plotly, Simple Dashboard creation, Dash components	10

SELF-LEARNING / TEAM WORK

Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project - Building an Interactive dashboard with Plotly and Dash	20
2	Review article based on peer reviewed original publications	10

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Data Analysis and Visualisation Using python- Analyze Data to Create Visualizations for BI Systems	Dr Ossama Embarak	Apress, 2018
2	Mastering Python Data Visualization	Kirthi Raman	Packt Publishing Ltd, UK, 2015

Reference

Sl. No.	Title of Book	Author	Publication
1	Hands-On Data Visualization	Jack Dougherty, Ilya Ilyankou	O'Reilly Media, 2021
2	Interactive Dashboards and Data Apps with Plotly and Dash: Harness the power of a fully-fledged frontend web framework in Python – no JavaScript required	Elias Dabbas	Packt Publishing, 2021
3	Python Data Analytics: With Pandas, NumPy, and Matplotlib, Second Edition	Fabio Nelli	Apress, 2023
4	Learning the Pandas Library: Python Tools for Data Munging, Data Analysis, and Visualization	Matt Harrison and Michael Prentiss	O'Reilly Media, 2016

Web Resource

1	Data Visualization with Python	Coursera
2	Python for Data Visualization and Analysis	Coursera

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Data visualization, importance, advantages, Categories and tools	L	CO1	U	1
	design principles, listing libraries of python, JavaScript, and R	L	CO1	A	1
	Dimensions and measures, types of data, visualizing charts using python, general theory, creation, interpretation, conditions, and disadvantages-	L	CO1	U	1
	Bar chart, Pie chart, stacked area chart, Line chart, Histogram, scatter plot, regression plot, Combining Bar and Line chart	L	CO1	A	1
	Numpy –Array, NaN and INF, Statistical Operations, Shape, Reshape, Ravel, Flatten, Sequence, Repetitions	L	CO1	A	1
	Random Numbers, Where, File Read and Write, Concatenate and Sorting, Dates	L	CO1	A	1
	Pandas -Data Frame and Series, File Reading and Writing, Info, Shape	L	CO1	A	1
	Duplicated, and Drop, Columns, NaN and Null Values, Imputation, Lambda Function,	L	CO1	A	1
2	Statistical functions, Data Visualisation With Pandas- Line Plot, Bar Plot, Stacked Plot	L	CO2	A	1
	Histogram, Box Plot, Area and Scatter Plot, Hex and Pie Plot, Scatter Matrix and Subplots	SS	CO2	U	1
	Series And Columns-Selecting A Single and multiple Column, Series Methods	L	CO2	U	1
	Using plot() to visualize Indexing And Sorting- Set_Index Basics, set_index:	L	CO2	A	1
	The World Happiness Index Dataset, setting index with read_csv, sort_values intro, sorting by multiple columns	L	CO2	A	1
	Data selection with loc, iloc,, Filtering Data Frames- Filtering data frames with a Boolean series, Filtering With Comparison Operators	L	CO2	A	1
	The Between Method, The isin()Method, Combining Conditions Using AND (&). Combining Conditions Using OR ()	L	CO2	A	1
	Bitwise Negation, isna() and notna() Methods, Modifying data frames	L	CO2	A	1
3	Renaming Columns and Index Labels, The replace () method, Updating Multiple Values Using loc[],	L	CO3	A	1
	Working With Types:- CastingTypesWith astype()	L	CO3	U	1
	Introducing the Category Type, Casting With pd.to_numeric(), dropna() and isna(), fillna()	L	CO3	U	1
	Matplotlib –Line Plot, Label, Scatter, Bar, and Hist Plots, Box Plot	L	CO3	U	1
	Subplot, Pie Plot Text Color, Nesting,&Labeling, Bar Chart, Line plot &Scatter plot on Polar Axis	L	CO3	A	1
	Animation Plot, Pandas Plotting –Changing Plot Styles, Adding Labels and Titles, rename()	L	CO3	A	1

	Mutiple plots on the Same Axes, Automatic Subplots	L	CO3	A	1
	Manual Subplots With Pandas, Exporting Figures With savefig(), Grouping and Aggregating	L	CO3	A	1
4	PANDAS: Hierarchical Indexing in pandas, Working With Text in pandas	L	CO4	A	1
	Pandas- Apply, Map And Applymap-, Combining Series And Dataframes	L	CO4	A	1
	Seaborn:- The Helpful load_dataset() method, Seaborn Scatterplots, Line plots. The relplot() Method, Resizing	L	CO4	U	1
	The relplot() Method, Resizing Seaborn Plots: Aspect & Height, Histograms, KDE Plots, Bivariate Distribution Plots, Rugplots, The Amazing displot() Method.	L	CO4	U	1
	Seaborn Categorical Plots- Countplot, Strip & Swarm Plots, Boxplots, Boxenplots, Violinplots, Barplots	L	CO4	U	1
5	Plots, Line Charts, Bar Charts, Bubble Plots, Box Plots, Histograms, Distplots, Heatmaps	L	CO5	A	1
	Dash Basics –dash layouts, - styling, Converting Simple Plotly Plot to Dashboard with Dash	L	CO5	U	1
	create a simple dashboard, Dash Components	L	CO5	U	1
	HTML Components, Core Components, Markdown with Dash	L	CO5	U	1
	Using Help() with Dash Interactive Components	L	CO5	A	1
	Single Callbacks for Interactivity, Dash Callbacks for Graphs	L	CO5	A	1
	Multiple Inputs &Outputs, Controlling Callbacks with Dash State	L	CO5	U	1
	Controlling Callbacks with Dash State, Interacting with Visualisation -Hover Over Data, Click Data, Selection Data	L	CO5	U	1
	Updating Graphs on Interactions	L	CO5	A	1
	Project: Building an Interactive Dashboard with Plotly and Dash Project Presentation	L	CO5	An	1
Plots, Line Charts, Bar Charts, Bubble Plots, Box Plots, Histograms, Distplots, Heatmaps	L	CO5	A	1	

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Python Visualization charts and Introduction to Numpy and Pandas	8		✓	✓				12
2	Pandas	8		✓	✓				12
3	Pandas & Matplotlib	8			✓				12
4	Pandas & Seaborn	6			✓				12
5	Python Dashboard with Plotly and Dash	10			✓	✓			12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
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Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD114D	REINFORCEMENT LEARNING					PE 1	

COURSE OBJECTIVES	
1	Introduce the core concepts and principles of reinforcement learning.
2	Apply RL algorithms to solve sequential decision-making tasks.
3	Implement and analyze advanced RL techniques using open-source tools.

COMPETENCY STATEMENTS	
CC1	Apply the fundamental principles of reinforcement learning by formulating policies, value functions, and Bellman equations to solve real-world machine learning tasks using open-source libraries.
CC2	Critically evaluate reinforcement learning algorithms and advanced techniques, including approximate solutions, by analysing their applications, strengths, and limitations.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Utilize the key features of reinforcement learning developing machine learning applications.	CC1	A
CO 2	Explore suitable learning tasks to which RL techniques can be applied.	CC1	A
CO 3	Apply core principles behind the RL, including policies, value functions, deriving Bellman equations.	CC2	A
CO 4	Implement and analyze approximate solutions	CC1	An
CO 5	Analyze current advanced techniques and applications in RL	CC2	An
CO 6	Practice using popular open-source library for implementing RL algorithms. (Cognitive knowledge level: Apply)	CC2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	-	-	3	-	3	3	-
2	-	-	3	-	3	3	-
3	-	-	3	-	3	3	-
4	-	-	2	3	3	3	-
5	-	-	3	-	2	2	-
6	2	2	2	3	3	3	3
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
							CIA	ESE	Total	CIA	ESE	Total	
3	0	0	0	30	70	3	40	60	100				100
L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination													

SYLLABUS (Major Topics)

Module	Title	Major Topics	Contact Hours
1	Introduction to reinforcement learning	Introduction to RL, Examples, Elements of RL, Multi-armed bandit problems, Actionvalue methods, The ten-armed testbed, Incremental implementation	8
2	Policies and value functions	Markov Decision Process, Goals and rewards, Returns and episodes, Policies and value functions, Policy evaluation, Policy improvement, Policy iteration, Value iteration	8
3	Q learning	Monte Carlo prediction, estimation and control, TD prediction, Sarsa, Q-learning, n-step TD prediction, n-step Sarsa, n-step Off-policy learning, Dyna	8
4	Function approximation	Value function approximation, Stochastic gradient methods, Linear methods, Non-linear function approximation, Episodic semi-gradient control, Semi-gradient n-step Sarsa, The λ return, TD(λ)	8
5	Policy approximation	Policy approximation, Policy gradient theorem, REINFORCE algorithm, Actor-Critic methods, Trust-Region Policy Optimization, Proximal Policy Optimization, Introduction to OpenAI Gym	8

SELF-LEARNING / TEAM WORK

Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project	15
2	Q-learning	5
3	Non-linear function approximation	5
4	Introduction to OpenAI	5

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Reinforcement learning: an introduction, Second edition,	Richard S. Sutton and Andrew G. Barto	MIT Press, 2018.

Reference

Sl. No.	Title of Book	Author	Publication
1	Algorithms for Reinforcement Learning	C. Szepesvari	Morgan and Claypool Publishers 2010
2	Reinforcement Learning: State-of-the-Art	M. Wiering and M. van Otterlo	Springer 2012

Web Resource

1	https://nptel.ac.in/courses/106106143	IIT Madras	Prof. Balaraman Ravindran
2	https://www.coursera.org/learn/dmrol	Columbia University	Tony Dear, Lecturer in Computer Science, Columbia University

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Introduction to RL.	L	CO1	U	1
	Examples	L	CO1	U	1
	Elements of RL	L	CO1	U	1
	Multi-armed bandit problems	L	CO1	A	1
	Action-value methods	L	CO1	A	1
	The ten-armed testbed	L	CO1	A	1
	Incremental implementation	L	CO1	A	1
2	Markov Decision Process	L	CO2	U	1
	Goals and rewards	L	CO2	U	1
	Returns and episodes	L	CO2	U	1
	Policies and value functions	L	CO2	U	1
	Policy evaluation	L	CO2	A	1
	Policy improvement	L	CO2	A	1
	Policy iteration	L	CO2	A	1
	Value iteration	L	CO2	A	1
3	Monte Carlo prediction, estimation and control	L	CO3	U	1
	TD prediction	L	CO3	A	1
	Sarsa	L	CO3	A	1
	Q-learning	SS	CO3	U	1
	n-step TD prediction	L	CO3	A	1
	n-step Sarsa	L	CO3	A	1
	n-step Off-policy learning	L	CO3	A	1
4	Dyna	L	CO4	U	1
	Value function approximation	L	CO4	A	1
	Stochastic gradient methods	L	CO4	A	1
	Linear methods	L	CO4	A	1
	Non-linear function approximation	SS	CO4	An	1
	Episodic semi-gradient control	L	CO4	An	1
	Semi-gradient n-step Sarsa	L	CO4	A	1
	The λ -return	L	CO4	A	1
	TD(λ)	L	CO4	A	1
5	Policy approximation	L	CO5, CO6	U	1
	Policy gradient theorem	L	CO5, CO6	U	1
	REINFORCE algorithm	L	CO5, CO6	U	1
	Actor-Critic methods	L	CO5, CO6	A	1
	Trust-Region Policy Optimization	L	CO5, CO6	An	1
	Proximal Policy Optimization	L	CO5, CO6	An	1
	Introduction to Open AI Gym	SS	CO5, CO6	U	1
	Introduction to Open AI Gym	L	CO5, CO6	U	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)	Total Marks
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			R	U	A	An	E	C	
1	Introduction to reinforcement learning	8		✓	✓				12
2	Policies and value functions	8		✓	✓				12
3	Q learning	8		✓	✓				12
4	Function approximation	8		✓	✓	✓			12
5	Policy methods	8		✓	✓	✓			12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD115D	COMPUTATIONAL LINGUISTICS					PE 1	

COURSE OBJECTIVES	
1	To introduce the fundamental concepts of computational approaches to language processing.
2	To develop knowledge of language models, phonology, morphology, semantics, and pragmatics for natural language understanding.
3	To enable students to apply NLP techniques such as POS tagging, word sense disambiguation, and language modeling for solving real-world tasks.

COMPETENCY STATEMENTS	
CC1	Students will be able to apply probabilistic models, context-free grammars, and feature structure unification methods to analyze linguistic data, thereby gaining the capability to model and interpret natural language with precision and efficiency.
CC2	Students will be able to design and develop practical NLP applications by integrating word sense disambiguation, information retrieval, and natural language generation concepts, equipping them to address real-world challenges in computational linguistics and intelligent systems.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Apply Probabilistic Models of Pronunciation and Spelling	CC1	A
CO 2	Apply the different methods for Parsing with Context-Free Grammars for English	CC1	A
CO 3	Apply basic concepts for Probabilistic Context-Free Grammars	CC1	A
CO 4	Apply the Unification of Feature Structures	CC1	A
CO 5	Apply the key concepts Word Sense Disambiguation and Information Retrieval	CC2	A
CO 6	Develop an application that uses Natural Language Generation concepts	CC2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	3	-	3	-	3	3	-
2	3	-	3	-	3	3	-
3	3	-	3	-	3	3	-
4	-	-	3	-	3	3	-
5	3	-	3	-	3	3	-
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Introduction	Words-Regular Expressions, Automata, Finite State Transducers, Probabilistic Modelling	8
2	Syntax	N-gram models- Part- of-Speech Tagging-Parsing with Context-Free Grammars	6
3	Probabilistic Context-Free Grammars	Probabilistic CYK-Learning PCFG Probabilities-Problems with PCFGs-Probabilistic Lexicalized CFGs-Human Parsing	7
4	Unification of Feature Structures	Feature Structures in the Grammar-Agreement-Head Features-Subcategorization-Long Distance Dependencies-Unification Data Structures-	6
5	Semantics and Pragmatics	Representing Meaning-Lexical Semantics-Word Sense Disambiguation-IR-Natural Language Generation-Machine Translation	7

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project	15
2	Review article	15

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition	Jurafsky, D. and J. H. Martin	Prentice-Hall, 2000.
2	Foundations of Statistical Natural Language Processing	Chris Manning and Hinrich Schütze,	The MIT Press
Reference			
Sl. No.	Title of Book	Author	Publication
1	Natural Language Understanding	J. Allen	Benjamin/Cummins
Web Resource			
1	https://nlp.stanford.edu/fsnlp/		
2	https://nlp.stanford.edu/links/statnlp.html		

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Words-Regular Expressions	L	CO1	U	2
	Automata	L	CO1	A	2
	Finite State Transducers	L	CO1	U	2
	Probabilistic Modelling	L	CO1	A	2
2	N-gram models	L	CO2	A	1
	Part- of-Speech Tagging	L	CO2	U	2
	Parsing with Context	L	CO2	U	2
	Free Grammars	L	CO2	A	1
3	Probabilistic CYK	L	CO3	U	2
	Learning PCFG Probabilities	L	CO3	U	1
	Problems with PCFGs	L	CO3	U	1
	Probabilistic Lexicalized CFGs	L	CO3	A	1
	Human Parsing	L	CO3	A	2
4	Feature Structures in the Grammar	L	CO4	A	1
	Agreement	L	CO4	A	1
	Head Features	L	CO4	U	1
	Subcategorization	L	CO4	U	1
	Long Distance Dependencies	L	CO4	U	1
	Unification Data Structures	L	CO4	A	1
5	Representing Meaning	L	CO5	A	1
	Lexical Semantics	L	CO5	U	1
	Word Sense Disambiguation	L	CO5	U	1
	IR, Natural Language Generation	L	CO5	U	2
	Machine Translation	L	CO5	A	2

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Introduction	8		✓	✓				12
2	Syntax	6		✓	✓				12
3	Probabilistic Context-Free Grammars	7		✓	✓				12
4	Unification of Feature Structures	6		✓	✓				12
5	Semantics and Pragmatics	7		✓	✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250902/CN116D	COMPUTATIONAL INTELLIGENCE					PE 1	

COURSE OBJECTIVES	
1	To impart knowledge of fuzzy logic principles and fuzzy inference systems for handling uncertainty, reasoning, and intelligent decision-making in engineering applications.
2	To develop the ability to design and apply evolutionary and swarm intelligence techniques such as Genetic Algorithms, Ant Colony Optimization, and Particle Swarm Optimization for solving optimization and complex real-world problems.
3	To enable learners to integrate computational intelligence methods into the design and development of intelligent systems that are efficient, adaptive, and scalable.

COMPETENCY STATEMENTS	
CC1	Ability to apply fuzzy logic, genetic algorithms, and swarm intelligence techniques to optimize, and solve engineering problems characterized by uncertainty and complexity.
CC2	Ability to design, develop, and implement intelligent computational solutions by integrating fuzzy inference, evolutionary algorithms, and swarm optimization methods to address real-world engineering and decision-making challenges.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Apply fuzzy logic to handle uncertainty and solve engineering problems.	CC1	A
CO 2	Apply Fuzzy Logic Inference methods in building intelligent machines.	CC2	A
CO 3	Design genetic algorithms for optimized solutions in engineering problems.	CC1	An
CO 4	Analyze the problem scenarios and apply Ant colony system to solve real optimization problems.	CC1	An
CO 5	Apply PSO algorithm to solve real world problems.	CC1	A
CO 6	Design, develop and implement solutions based on computational intelligence concepts and techniques.	CC2	C

Cognitive (Revised blooms Level): - **R:** Remember; **U:** Understand; **A:** Apply; **An:** Analyse; **E:** Evaluate; **C:** Create

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	-	2	-	1	-
2	2	-	2	2	3	1	-
3	3	-	3	2	3	1	-
4	3	-	3	2	3	1	-
5	2	-	3	2	3	1	-

Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Fuzzy Logic	Crisp sets vs fuzzy sets, Fuzzy Composition-	9
2	Fuzzy Systems	Fuzzy Reasoning, Fuzzy Controllers	7
3	Genetic Algorithms	Genetic Algorithms, operations	7
4	Ant Colony Systems	Ant Colony Systems, Working	8
5	Particle Swarm Optimization	Particle Swarm Optimization, Working	9

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project – Data interpretation	14
2	Review article	14

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Introduction to Soft Computing Neuro-Fuzzy Genetic Algorithms,	Samir Roy, Udit Chakraborty	Pearson, 2013
2	Artificial Intelligence and Intelligent systems	N.P. Padhy	Oxford Press, New Delhi, 2005
Reference			
Sl. No.	Title of Book	Author	Publication
1	Nature- Inspired Optimization Algorithms	J. O. Moreira, Andre Carvalho, Tomas Horvath,	Wiley 2019.
2	Feature Engineering For Machine Learning and Data Analytics	Xin- She Yang School of Science & Technology	Elsevier, 1 st edition, 2014
3	An Introduction to Genetic Algorithm	Mitchell Melanie	Prentice Hall, 1998
Web Resource			
1	https://nptel.ac.in/courses/127105006	NPTEL	
2	https://nptel.ac.in/courses/111102130	NPTEL	

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Crisp sets vs fuzzy sets, Operations & properties of fuzzy sets	L	CO1	U	1
	Membership functions	L	CO1	U	1
	Linguistic Variables	L	CO1	U	1
	Operations on fuzzy sets	L	CO1	A	1
	Fuzzy laws	L	CO1	U	1
	Operations on fuzzy relations	L	CO1	A	1
	Fuzzy Composition- Max- min	L	CO1	A	1
	Fuzzy Composition – Max- Product	L	CO1	A	1
2	Alpha-cut representation	L	CO1	A	1
	Fuzzy Reasoning – GMP	L	CO2	U	1
	Fuzzy Reasoning –GMT	L	CO2	U	1
	Fuzzy Inference System	L	CO2	U	1
	Defuzzification methods	L	CO2	U	1
	Fuzzy Controllers	L	CO2	A	1
	Mamdani Model	L	CO2	U	1
	Larsen Model	L	CO2	U	1
3	Introduction to Genetic algorithm	L	CO3	U	1
	Theoretical foundation	L	CO3	U	1
	GA encoding - decoding	L	CO3	An	1
	GA operations	L	CO3	An	1
	Elitism, GA parameters, Convergence of GA	L	CO3	A	1
	Multi – objective Genetic Algorithm	L	CO3	A	1
	Pareto Ranking	L	CO3	A	1
4	Swarm intelligent systems	L	CO4	U	1
	Background	L	CO4	U	1
	Ant colony systems – biological systems	L	CO4	U	1
	Development of the ant colony system	L	CO4	U	1
	Working	L	CO4	U	1
	Pheromone updating	L	CO4	U	1
	Types of ant systems	L	CO4	U	1
	ACO algorithms for TSP	L	CO4	A	1
5	Basic Model	L	CO5	U	1
	Global Best PSO	L	CO5	U	1
	Local Best PSO, Comparison of 'gbest' to 'lbest'	L	CO5	A	1
	PSO Algorithm Parameters	L	CO5	A	1
	Problem Formulation	L	CO5	An	1
	Working	L	CO5	A	1
	Rate of convergence improvements – velocity clamping	L	CO5	A	1
	Inertia-weight - Constriction Coefficient- Boundary Conditions	L	CO5	A	1
	Initialization, Stopping Criteria, Iteration Terms and Function, Evaluation	L	CO5	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN				
Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)	Total Marks

			R	U	A	An	E	C	
1	Fuzzy Logic	9		✓	✓				12
2	Fuzzy Systems	7		✓	✓				12
3	Genetic Algorithms	7		✓	✓				12
4	Ant Colony Systems	8		✓	✓				12
5	Particle Swarm Optimization	9			✓	✓			12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name						Course Category
M250101/ AD121E	ADVANCED DATABASE						PE 2
Pre-requisite							
Database Management Systems							

COURSE OBJECTIVES	
1	To provide an exposure to the concepts and techniques in advanced database management
2	To develop applications that manage data efficiently with the help of suitable data models and techniques.

COMPETENCY STATEMENTS	
CC1	Apply advanced database concepts including relational modelling, normalization, indexing, query processing, and optimization strategies to design efficient and reliable database systems.
CC2	Analyze and implement distributed architectures, semi-structured data management techniques, and modern database technologies to develop innovative and scalable data-driven applications.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Apply concepts from relational database systems and various normalization techniques to construct and manipulate relational models effectively.	CC1	A
CO 2	Employ the features of database storage, file organization, database accessing and indexing in database applications.	CC1	A
CO 3	Evaluate and improve query processing and optimization using performance metrics.	CC1	A
CO 4	Analyze implementation aspects of distributed system on database architecture.	CC2	A
CO 5	Apply Semi structured data, XML and XML queries for data management.	CC2	A
CO 6	Design, Develop, and Implement innovative ideas on advanced database concepts and techniques.	CC2	C
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	2	3	-	1	-
2	2	-	2	3	-	1	-
3	2	-	2	3	-	1	-
4	2	-	3	3	-	1	-
5	2	-	2	3	2	2	-
6	3	2	3	3	3	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Relational Databases	Relational Model, Normalization	11
2	Query Processing and Optimization	Hashing Techniques & Indexing	8
3	Introduction to Query Processing and Optimization	Measures of query cost, Optimization of Relational Algebra expressions	6
4	Distributed System Architecture	Distributed Query Processing	6
5	XML, XPath, Non-relational Databases	XML, Nonrelational Distributed Databases	9

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Review article based on peer reviewed original publications	10
2	Micro-project	20

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Fundamentals of Database Systems	Ramez Elmasri, Shamkant B. Navathe	Pearson Education, 6th Edition, 2007.
2	Database System Concepts	Korth, S. Sudarshan, Abraham Silberschatz, Henry F	McGraw Hill Education, 6th Edition, 2011
Reference			
Sl. No.	Title of Book	Author	Publication
1	Next Generation Databases: NoSQL, NewSQL, and Big Data	Guy Harrison	Apress, 1st Edition, 14 December 2015
2	Database Principles: Fundamentals of Design, Implementation and Management	Rob, Peter and Carlos Coronel	9th Edition, 2011.
3	Database systems- A Practical Approach to Design, Implementation and Management	Thomas M Connolly and Carolyn E Begg	Pearson Education, 4th Edition (2014)
Web Resource			
1	https://onlinecourses.nptel.ac.in/noc22_cs91/preview		
2	https://nptel.ac.in/courses/106104135		
3	https://onlinecourses.swayam2.ac.in/ini24_cs01/preview		

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Relational Databases – Relational Model, Normalization				11
	Relational Model Introduction - Structure of Relational Database,	L	1	A	1
	database Schema, Keys		1	A	
	The Relational Algebra: Fundamental Operations	L	1	A	1
	The Entity-Relationship model: Entity Set, Relationship Set,	L	1	A	1
	Attributes, Constraints: Mapping cardinalities-E-R Diagrams		1	A	
	Real world Scenarios – ER diagrams	L	1	A	1
	Different anomalies in designing a database	L	1	A	1
	Normalization - The Need for Normalization, Process		1	A	
	Armstrong's axioms	L	1	A	1
	Rules for Functional Dependencies, Closures & their computation		1	A	
	First Normal Form, Second Normal Form, Third Normal Forms	L	1	A	1
	Boyce/Codd Normal Form	L	1	A	1
	Functional Dependencies- Minimal cover, Equivalence	L	1	A	1
	Properties of Relational Decomposition	L	1	A	1
Algorithms for Relational Database Design	L	1	A	1	
2	Query Processing and Optimization				8
	Review of terms: physical and logical records,	L	2	A	1
	Placing file records on disk- Record types, Record blocking and spanned versus Unspanned records		2	A	
	Hashing techniques –Internal, External hashing for disk files	L	2	A	1
	Indexing and Hashing: Basic concept Ordered Indices	L	2	A	1
	B+ tree Index Files:	L	2	A	1
	Structure of a B+- Tree (structure only, algorithms not needed)	L	2	A	1
	Indexes on Multiple keys	L	2	A	1
	Hash Indexes, Bitmap indices	L	2	A	1
Indexing spatial data	L	2	A	1	
3	Introduction to Query Processing and Optimization				6
	Measures of query cost	L	3	A	1
	Algorithms for Selection with cost analysis	L	3	A	1
	Algorithms for Join with cost analysis	L	3	A	1
	Evaluation of expressions	L	3	A	1
	Heuristics in Query Optimization	S	3	A	1
Optimization of Relational Algebra expressions	L	3	A	1	
4	Distributed System Architecture				6
	Introduction to Distributed System architecture	L	4	A	1
	Distributed storage & Distributed file systems	L	4	A	1
	Distributed RDB design & its Transparency	L	4	A	1
	Distributed Transactions	L	4	A	1
	Commit Protocols & Concurrency Control	L	4	A	1
Distributed Query Processing	L	4	A	1	
5	XML, XPath, Non-relational Databases				9

Introduction to Semi-structured Data and XML Databases	L	5	A	1
XML Data Model – XSD	L	5	A	1
XML: DTD and XML Schema, XML presentation	L	5	A	1
XPath Queries	L	5	A	1
XQuery	L	5	A	1
Next Generation Databases: Distributed Relational Databases -	L	5	A	1
Introduction to NoSQL databases,	L	5	A	1
Nonrelational Distributed Databases		5	A	
MongoDB Sharding and Replication	L	6	C	1
Object Relational Systems	L	6	C	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Relational Databases	11			✓	✓			12
2	Query Processing and Optimization	8		✓	✓	✓			12
3	Introduction to Query Processing and Optimization	6			✓	✓			12
4	Distributed System Architecture	6			✓	✓			12
5	XML, XPath, Non-relational Databases	9		✓	✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/AD122E	CONCEPTS IN CLOUD COMPUTING					PE 2	

COURSE OBJECTIVES	
1	To provide a strong foundation in cloud computing concepts and OpenStack architecture.
2	To equip students with practical knowledge of compute, storage, networking, orchestration, and high availability in cloud systems.
3	To develop the ability to design, analyze, and implement innovative cloud-based solutions for real-world applications.

COMPETENCY STATEMENTS	
CC1	Able to apply cloud computing concepts and OpenStack services to design and deploy scalable applications
CC2	Competent in analyzing, comparing, and implementing cloud infrastructure components for effective problem-solving.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Make use of the concepts in cloud computing and OpenStack logical architecture to develop applications.	CC1	A
CO 2	Explore OpenStack cloud controller and common services.	CC2	A
CO 3	Compare different Open Stack compute service components and storage types.	CC2	A
CO 4	Compare different Open Stack compute service components and storage types.	CC1	An
CO 5	Analyse the orchestration, HA and failover in OpenStack.	CC2	An
CO 6	Analyse the orchestration, HA and failover in OpenStack.	CC1,CC2	An
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	1	3	2	2	1	1
2	2	1	2	2	3	1	1
3	2	1	3	2	2	1	1
4	2	1	3	3	2	1	1
5	2	1	2	3	2	1	1
6	3	2	3	3	3	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Overview of OpenStack	Fundamentals of Cloud Computing and Service Models	6
2	OpenStack cluster - Controller and common services	OpenStack Cluster – The Cloud Controller and Common Services	5
3	OpenStack compute and Storage	OpenStack Compute and Storage	11
4	OpenStack Networking	OpenStack Neutron Networking	9
5	OpenStack Orchestration, HA and Failover	OpenStack Orchestration, High Availability (HA), and Failover	9

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project – Data interpretation	14
2	Review article	14
3	Attributes and Data Types	2

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Mastering OpenStack	Omar Khedher, Chandan Datta Chowdhury	2nd Edition, Packt Publishing, 2017
Reference			
Sl. No.	Title of Book	Author	Publication
1	OpenStack Operations Guide	Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian	Guide, O'REILLY, 1/e, 2014
2	OpenStack Design Pattern	Uchit Vyas, Applied	Apress, 1/e, 2016
3	OpenStack in action	V. K. Cody Bumgardner	Manning, 2016
4	Implementing Cloud Storage with OpenStack Swift	Amar Kapadia, Sreedhar Varma, Kris Rajana	Packt Publishing, 2014
Web Resource			
1	https://docs.openstack.org/wallaby/?_ga=2.231002015.1428061357.1620834394-		

DETAILED SYLLABUS					
				Learning	

Module	Topic	Mode of Delivery	COs	Domain Level	Hours
				C	
1	Introduction to cloud computing, private cloud, public cloud, hybrid cloud architecture.	L	CO1	A	1
	Cloud Services - Infrastructure as a Service, Platform as a Service, Storage as a Service	L	CO1	A	1
	Designing OpenStack Cloud Architectural Consideration - OpenStack - The new data center paradigm -OpenStack logical architecture	L	CO1	A	1
	Nova - Compute service. Neutron - Networking services	L	CO1	A	1
	Gathering the pieces and building a picture	L	CO1	A	1
	Correlation-Linear, Causality Chi-Square tests	L	CO1	A	1
2	OpenStack Cluster – The Cloud Controller and Common Services Asymmetric clustering, Symmetric clustering	L	CO2	A	1
	The cloud controller - The keystone service, The nova-conductor service	SS	CO2	A	1
	The nova-scheduler service, The API services, Image management.	L	CO2	A	1
	The network service	L	CO2	A	1
	The horizon dashboard, The telemetry services	L	CO2	A	1
3	The compute service components-Deciding on the hypervisor OpenStack Magnum project.	L	CO3	A	1
	Segregating the compute cloud	L	CO3	A	1
	Over commitment considerations.	L	CO3	A	1
	Storing instances' alternatives. Understanding instance booting.	L	CO3	A	1
	Planning for service recovery.	L	CO3	A	1
	OpenStack Storage - -	L	CO3	A	1
	Block, Object, and File Share	L	CO3	A	1
	Understanding the storage types.	L	CO3	A	1
	A spotlight on swift.	L	CO3	A	1
	Deploying swift service.	L	CO3	A	1
Using Block Storage Service Cinder	L	CO3	A	1	
4	The architecture of Neutron.	L	CO4	An	1
	Implementing virtual networks - VLAN, Tunnel based.	L	CO4	An	1
	Virtual Switches, The ML2 Plugin	L	CO4	An	1
	Neutron Subnets Connecting virtual networks with routers	L	CO4	An	1
	Configuring the routing service Connecting networks using a virtual router	L	CO4	An	1
	Connecting to the external world	L	CO4	An	1
	Connectivity from the external world,	L	CO4	An	1
	Associating a floating IP Implementing network security in OpenStack- Part 1	L	CO4	An	1
	Associating a floating IP Implementing network security in OpenStack- Part 2	L	CO4	An	1
5	Orchestration in OpenStack,	L	CO5	An	1
	Heat and its Components.	L	CO5	An	1
	Stacking in OpenStack	L	CO5	An	1
	OpenStack orchestration with Terraform	L	CO5	An	1
	Scope of HA	L	CO5	An	1
	Scope of HA in OpenStack	L	CO5	An	1
	HA in the database.	L	CO5	An	1

	HA in the Queue	L	CO5	An	1
	Implementing HA on RabbitMQ	L	CO5	An	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Overview of OpenStack	6			✓				12
2	OpenStack cluster - Controller and common services	5			✓				12
3	OpenStack compute and Storage	11			✓				12
4	OpenStack Networking	9				✓			12
5	OpenStack Orchestration, HA and Failover	9				✓			12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work</i>							
Course Code	Course Name					Course Category	
M250101/AD123E	STATISTICS FOR DATA SCIENCE					PE 2	

COURSE OBJECTIVES	
1	To develop a strong understanding of the core concepts in statistics and probability, including descriptive statistics, hypothesis testing, regression analysis, and analysis of variance
2	To introduce advanced regression and machine learning methods such as logistic regression, polynomial regression, and decision trees for data analysis.
3	To enable students to work with diverse types of data, apply appropriate analytical techniques, and make informed, data-driven decisions.

COMPETENCY STATEMENTS	
CC1	Apply statistical and analytical techniques including descriptive, inferential, and predictive methods to organize, visualize, and interpret data for data science, AI, and machine learning applications.
CC2	Implement appropriate statistical tools and programming environments (e.g., Python, MATLAB, R) to perform hypothesis testing, regression, clustering, and model evaluation for drawing valid data-driven inferences.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Apply fundamental statistical methods including bar plots, ANOVA, regression, k-means, t-tests, and non-parametric permutation testing to solve problems in machine learning, AI, and data science.	CC 1, CC 2	A
CO 2	Visualize data effectively using descriptive, inferential, and predictive techniques appropriate to different stages of data analytics.	CC 1	A
CO 3	Analyze datasets by applying measures of central tendency (mean, median, mode) and measures of dispersion (range, IQR, box-and-whisker plots).	CC 1	A
CO 4	Select and apply appropriate statistical techniques at relevant stages of a data analytics project.	CC1, CC2	A
CO 5	Implement statistical methods and workflow using programming environments such as Python or MATLAB.	CC 2	A
CO 6	Perform hypothesis testing and draw valid inferences to support machine learning model development and evaluation.	CC 2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	1	2	2	2	-
2	2	-	2	3	3	3	-
3	3	-	2	3	3	3	-
4	3	-	3	3	3	3	-
5	3	-	3	3	3	2	-
6	3	3	3	3	3	3	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100	0	0	0	

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Descriptive Statistics	DATA, Types of data, data, Sample vs. population data, Samples (N=1 & N>1 studies), Visualizing Data, Implementation in Python.	7
2	Data Normalisation and Probability	Z-score standardization, Min-max scaling, Euclidean distance for outlier removal, Implementation Probability, Random Variables.	8
3	Sampling & Hypothesis Testing	Sampling Types of studies, Hypothesis Testing, Cross-validation, Statistical significance vs. classification accuracy, The T-Test Family	8
4	Confidence Intervals & ANOVA	Confidence Intervals on Parameters, Correlation, Analysis of Variance, ANOVA, Regression	8
5	Regression, Clustering, And PCA	Regression, Statistical Power, And Sample Tests, Clustering and Dimension Reduction, Signal Detection Theory.	9

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Visualization of data using boxplots and violin plots	2
2	Understanding statistical moments (mean, variance, skewness, kurtosis)	2
3	Shannon entropy and its role in information theory	2
4	Z-score vs. Min-Max scaling in Python	2
5	Handling multivariate outliers (Mahalanobis distance)	2
6	Monte Carlo sampling and applications in probability estimation	2
7	Understanding Type I and Type II errors with real-world examples	2
8	Nonparametric tests (Mann-Whitney U & Wilcoxon signed rank)	2
9	Permutation testing and its implementation in Python	2
10	Bootstrapping methods for confidence interval estimation	2
11	Comparing Pearson, Spearman, and Kendall correlations –	2
12	Interpreting ANOVA output tables (F-test & post-hoc comparisons)	2
13	Logistic regression and its applications in classification	2
14	Clustering with DBSCAN vs. K-Means	2
15	Principal Component Analysis (PCA) for dimensionality reduction	2

SUGGESTED LEARNING RESOURCES

Text Books			
Sl. No.	Title of Book	Author	Publication
1	Statistics and Data Analytic	A. Abebe, J. Daniels, J. W. Makean	Statistical Computation Lab, Western Michigan University, Kalamazoo.2001
2	Statistics with JMP: Graphs, Descriptive Statistics, and Probability	Peter Goos and David Meintrup	WILEY 2015
3	Statistics with JMP: Hypothesis Tests, Anova, and Regression	Peter Goos and David Meintrup,	WILEY 2016
4	Statistical and Machine-Learning Data Mining-Techniques for Better Predictive Modeling and Analysis of Big Data	Bruce Ratner,	Third Edition, CRC Press, Tailor and Francis group, 2017
5	Naked Statistics_Stripping the Dread from the Dat	Charles Wheelan	W.W. Norton Company, New York, 2014

References			
Sl. No.	Title of Book	Author	Publication
1	Bayesian Computation with R	Jim Albert	2nd Edition, Springer 2009
2	Data Mining, Inference and Statistics	Trevor Hasti, Robert Tibshirani, Jerome Friedman	2nd Edition, Springer Series in Statistics 2008

Web Resource	
1	https://www.khanacademy.org/math/statistics-probability
2	https://www.coursera.org/specializations/statistics-with-python
3	https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/
4	https://towardsdatascience.com
5	https://www.youtube.com/c/joshstarmar
6	https://www.analyticsvidhya.com/blog/category/statistics/
7	https://scikit-learn.org/stable/
8	https://online-learning.harvard.edu/subject/statistics-and-data-analysis
9	https://www.datacamp.com

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	COs	Learning Domain Level (C)	Hours
1	Types of data, Sample vs. population data, Samples	L	1	A	1
	Visualizing Data: Bar plots. Box-and-whisker plots, Boxplots of normal and uniform noise, Histograms	L	1	A	1
	Histogram proportion, Pie charts, implementation	L	1	A	1
	Descriptive vs. inferential statistics, Accuracy, precision, and resolution. Data distributions, histograms of distributions	L	1	A	1
	Measures of central tendency, central tendencies with outliers	L	1	A	1
	Measures of dispersion Interquartile range, QQ plots, Statistical moments	L	1	A	1

	Histograms: Violin plots, Shannon entropy, entropy, and number of bins, code	L	1	A	1
2	Data Normalization and Probability: Z-score standardization, minmax scaling, removing outliers: z-score method, The modified z-score method, z vs. modified-z	L	2	A	1
	Multivariate outlier detection, Euclidean distance for outlier removal, Removing outliers by data trimming, non-parametric solutions to outliers	L	2	A	1
	Probability: Computing probabilities	L	2	A	1
	Probability mass vs. density, PDF, CDF. CDFs for various distributions	L	2	A	1
	Creating sample estimate distributions, Monte Carlo sampling, Sampling variability, noise, and other annoyances, Expected value, Conditional probability, and Tree diagrams	L	2	A	1
	The Law of Large Numbers, The Central Limit Theorem, Implementation	L	2	A	1
	Random Variables: Binomial and Poisson RV, Bernoulli, and Geometric random variables	L	2	A	1
3	Sampling: Types of studies, Sampling, and bias, Sampling distribution of the sample mean	L	3	A	1
	Conditions for inference with the SDSM Sampling distribution of the sample proportion, Conditions for inference with the SDSP	L	3	A	1
	Hypothesis Testing: Independent and Dependent Variables, models, residuals, Sample distributions under null and alternative hypotheses	L	3	A	1
	P-values: definition, tails, and misinterpretations, P-z combinations that you should memorize, Degrees of freedom, Type 1 and Type 2 errors	L	3	A	1
	Parametric vs. non-parametric tests, Multiple comparisons, and Bonferroni correction, Statistical vs. theoretical vs. clinical significance, Cross-validation, Statistical significance vs. classification accuracy	L	3	A	1
	The T-Test Family: Purpose and interpretation, One-sample t-test, The role of variance, Two-samples t-test	L	3	A	1
	Importance of N for t-test, Wilcoxon signed-rank (nonparametric t-test)	L	3	A	1
4	Mann-Whitney U test (nonparametric t-test), U test, Permutation testing for t-test, significance, Python Implementation	L	3	A	1
	Confidence Intervals on Parameters: Computing confidence intervals via formula, Confidence intervals via bootstrapping (resampling), Misconceptions about confidence intervals	L	4	A	1
	Correlation: Motivation and description of correlation, Covariance, and correlation: formulas, Correlation matrix	L	4	A	1
	Correlation to the covariance matrix, Partial correlation, The problem with Pearson, Nonparametric correlation: Spearman rank, Fisher-Z transformation for correlations	L	4	A	1
	Spearman correlation, the confidence interval on the correlation, Kendall's correlation for	L	4	A	1

	ordinal data, The subgroups correlation paradox, Cosine similarity				
	Analysis of Variance: Sum of squares, The F-test and the ANOVA table, The omnibus F-test and posthoc comparisons	L	4	A	1
	The two-way ANOVA, One-way ANOVA example,	L	4	A	1
	Two-way ANOVA example	L	4	A	1
	Regression: Introduction to GLM / regression, Least-squares solution to the GLM, Evaluating regression models: R2 and F, Simple regression, code	L	4	A	1
5	Regression: Multiple regression, Standardizing regression coefficients	L	5	A	1
	Polynomial regression models, Logistic regression	L	5	A	1
	Under and over-fitting, comparing "nested" models, missing data	L	5	A	1
	Statistical Power and Sample Tests Estimating statistical power and sample size Compute power and sample size using G*Power	L	5	A	1
	Clustering And Dimension-Reduction- K-means clustering, K-means, and normalization, K-means on a Gauss blur, Clustering via DBSCAN	L	5	A	1
	DBSCAN vs. k-means, K-nearest neighbor classification, Principal components analysis	L	5	A	1
	k-means on PC data, independent components analysis	L	5	A	1
	Signal Detection Theory: d-prime, Response bias	L	5	A	1
	F-score, Receiver operating characteristics (ROC), Python Implementation	L	5	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Descriptive Statistics	7			✓				12
2	Data Normalisation and Probability	8			✓				12
3	Sampling and Hypothesis Testing	8			✓				12
4	Confidence Intervals, Correlation and Anova	8			✓				12
5	Regression, Clustering and PCA	9			✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work</i>							
Course Code	Course Name						Course Category
M250101/AD124E	ETHICS FOR DATA SCIENTISTS						PE 2

COURSE OBJECTIVES	
1	Understand the basic ethical and legal issues related to using data.
2	Recognize the positive and negative impacts of data on society.
3	Learn to apply ethical thinking to real-world data science problems.

COMPETENCY STATEMENTS	
CC1	Apply appropriate ethical and legal standards when managing data collection and sharing.
CC2	Demonstrates the ability to apply ethical principles, legal standards, and societal values to responsible data science practises

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Applying the concept of ethics, and the necessity and the benefit of adopting shared ethical principles in Data Science	CC1	A
CO 2	Analyze the role of an IRB in a human subject's study and the difference between data collected for business purposes versus research purposes and relate how this changes the requirement for IRB approval.	CC1	A
CO 3	Distinguish between the three main categories of intellectual property and identify the data owner	CC1	A
CO 4	Describe the reasonable expectation of privacy relates to data collection and recognize the voluntary limits on the use of data that arise out of social consensus	CC1	A
CO 5	Apply data ethics while practicing Data Science.	CC2	A
CO 6	Identify invalid data, incorrect models, bias in algorithms, and bad analysis conducted on good data	CC2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	3	-	-	-	3	-
2	3	2	2	-	-	3	-
3	-	3	-	-	-	2	-
4	-	3	-	-	-	-	-
5	3	2	3	3	3	3	-
6	3	2	3	2	3	3	-
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100	0	0	0	

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Hrs
1	Introduction to Ethics	Ethics, Need of Data Science Ethics	8
2	Data Ownership and Privacy	Data Ownership and Privacy, Intellectual Property rights, Privacy risks	8
3	Data Validity	Validity, Choices of Attributes and Pressures, Errors in Model Design	8
4	Algorithmic Fairness	Introduction, Correct and Misleading Results. P Hacking	8
5	Societal Consequences	Societal Impact, Code of Ethics	8

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs
1	Review article based on peer reviewed original publications	10
2	Course based task	10
3	Seminar	10

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Ethics and Data Science	Mike Loukides, Hilary Mason, and DJ Patil	O'Reilly Media, 2018
2	An Introduction to Data Ethics	Shannon Vallor, Ph.D. William J. Rewak	Santa Clara University, 2019
Reference			
Sl. No.	Title of Book	Author	Publication
1	Ethics of Big Data	Kord Davis	O'Reilly Media, 2012
2	Data Ethics and Challenges	Samiksha Shukla, Jossy P. George, Kapil Tiwari, Joseph Varghese Kureethara	Springer 2022
3	Artificial Intelligence: Embracing Our Humanity to Maximize Machines	John C. Havens	2016
Web Resource			
1	www.coursera.org/learn/data-science-ethics		Coursera
2	https://courses.edx.org/courses/course-v1:MichiganX+DS101x+1T2018		edX

DETAILED SYLLABUS

Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Ethics, Definition, Data Ethics	L	CO1	U	1
	Need of Data Science Ethics. Examples	L	CO1	A	1
	Case Study and Discussion	L	CO1	U	1
	Human Subject Research and Informed Consent, Cases	L	CO1	A	1
	US Institutional Review Board (IRB), IRB in India, Limitations of Informed Consent	L	CO2	A	1
	Case Study and Discussion	L	CO2	A	1
	Case Study and Discussion	L	CO2	A	1
	Case Study and Discussion	L	CO2	A	1
2	Data Ownership and Privacy	L	CO3	U	1
	Intellectual Property rights	L	CO3	U	1
	Privacy: Introduction, History, Degrees. Privacy Risks	L	CO3	A	1
	Case Studies, and Discussion, Targeted Ads, The Naked Mile	SS	CO3	A	1
	Sneaky Mobile Apps 1	L	CO3	A	1
	Anonymity Introduction, De-Identification	L	CO3	A	1
	Case Studies and Discussion	L	CO3	A	1
	Introduction, Choices of Attribute and Pressures	L	CO3	U	1
3	Errors in Data Processing	L	CO3	U	1
	Errors in Model Design	L	CO3	U	1
	Managing Change, Case Study- Three Blind Mice Algorithms and Race	L	CO3	A	1
	Case Study- Algorithms in the Office	L	CO3	A	1
	Case Study- GermanWings Crash	L	CO3	A	1
	Google Flu and Discussion	L	CO3	A	1
	Case Studies and Discussion	L	CO3	A	1
	Introduction, Correct and Misleading Results	L	CO5, CO6	U	1
4	P Hacking	L	CO5	U	1
	Case Study- High Throughput Biology	L	CO5	U	1
	Geopricing, Case Study- Your Safety Is My Lost Income	L	CO5, CO6	A	1
	Case Study- Discussion- fairness of applying face recognition to give preference to the often-visiting customers in business	L	CO5, CO6	A	1
	Case Studies and Discussion	L	CO5	A	1
	Case Studies and Discussion	L	CO5	A	1
	Case Studies and Discussion	L	CO5, CO6	A	1
	Introduction, Societal Impact	L	CO4	U	1
5	Ossification	L	CO4	U	1
	Surveillance	L	CO4	U	1
	Code of ethics, wrap-up	L	CO4	U	1
	Case Studies- Social Credit Scores, and Discussion	L	CO4	A	1
	Case Studies- Predictive Policing, and Discussion	L	CO4	A	1
	Case Study and Discussion	L	CO4	A	1
	Case Study and Discussion	L	CO4	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Introduction to Ethics	8		✓	✓				12
2	Data Ownership and Privacy	8		✓	✓				12
3	Data Validity	8			✓				12
4	Algorithmic Fairness	8			✓	✓			12
5	Societal Consequences	8			✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Weightage
Continuous Internal Assessment	40
Learning Activity – Review Article	15
Internal Examination	10
Course Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work</i>							
Course Code	Course Name					Course Category	
M250101/AD125E	SPEECH PROCESSING					PE 2	
Pre-requisite							
Digital Signal Processing							

COURSE OBJECTIVES	
1	To provide students with a fundamental understanding of speech processing concepts, including computational phonology, models of spelling and pronunciation, speech synthesis, and speech recognition.
2	To enable learners to design and develop practical applications that incorporate speech processing techniques for real-world use.

COMPETENCY STATEMENTS	
CC1	Develop an understanding of human speech mechanisms, acoustic processing, error detection and correction, as well as pronunciation models that form the foundation of speech systems.
CC 2	Apply speech processing concepts for building automatic speech recognition, transcription systems, and innovative real-world applications.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Analyse the different aspects of production of speech in humans	CC 1	An
CO 2	Analyse the different aspects of production of speech in humans	CC 1	A
CO 3	Illustrate the various models for speech pronunciation variations	CC 1	A
CO 4	Make use of the different models for recognizing human speech and converting it into equivalent text	CC1	A
CO 5	Comprehend the processes involved in the acoustic processing of human speech	CC 2	A
CO 6	Design, develop, and implement innovative ideas on speech processing concepts and techniques	CC 2	C
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	-	-	3	-	-	3	-
2	-	-	3	-	3	3	-
3	-	-	3	-	3	3	-
4	-	-	3	-	-	3	-
5	-	-	3	-	-	3	-
6	3	3	3	3	3	3	3
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
3	0	0	0	30	70	3	CIA	ESE	Total	CIA	ESE	Total	100
							40	60	100				

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Hrs
1	Computational Phonology	Articulatory Phonetics, Vocal Organs, Consonants, Phonemes, and Phonological Rules	8
2	Speech Synthesis	Mapping Text to Phonemes for TTS, FST based Pronunciation Lexicon, Prosody in TTS	8
3	Models of Spelling and Pronunciation	Spelling errors, Probabilistic Models of Spelling, Computing Likelihoods from Weighted Automata - The Forward Algorithm, Segmentation	10
4	Speech Recognition	Speech Recognition Architecture, HMM models, Advanced methods of Decoding	7
5	Acoustic processing of speech	Sound Waves, Feature Extraction, Training a Recognizer	7

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project – Data interpretation	14
2	Review article	14
3	Attributes and Data Types	2

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No	Title of Book	Author	Publication
1	Speech Recognition	Claudio Becchetti and Lucio Prina Ricotti	John Wiley and Sons, 1999
2	Speech and Audio Signal Processing, Processing and Perception of Speech and Music	Ben Gold and Nelson Morgan	Wiley- India Edition, 2006
Reference			
Sl. No	Title of Book	Author	Publication
1	Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition,	Jurafsky, D. and J. H. Martin,	Upper Saddle River, NJ: Prentice-Hall, 2000
2	Statistical Methods of Speech Recognition	Frederick Jelinek	MIT Press, 1997
4	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models	Dan Jurafsky and James H. Martin	3 rd edition Stanford University, 2025
Web Resource			
1	https://onlinecourses.nptel.ac.in/noc22_ee117/preview	IIT Kharagpur	Prof. Shyamal Kumar Das Mandal
2	https://onlinecourses.nptel.ac.in/noc22_ee62/preview	IIT Kharagpur	Prof. Shyamal Kumar Das Mandal

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hours
				C	
1	Articulatory Phonetics - Introduction	L	CO1	An	1
	Production and Classification of Speech Sounds	L	CO1	An	1
	Vocal Organs	L	CO1	An	1
	Consonants Place of Articulation	L	CO1	An	1
	Consonants – Manner of Articulation	L	CO1	An	1
	Articulation of vowels	L	CO1	An	1
	Phoneme and Phonological Rules	L	CO1	An	1
2	Mapping Text to Phonemes for TTS	L	CO2	A	1
	Pronunciation Dictionaries	SS	CO2	A	1
	Text Analysis	L	CO2	A	1
	FST-based Pronunciation Lexicon	L	CO2	A	1
	Prosody in TTS	L	CO2	A	1
	Phonological Aspects of Prosody	L	CO2	A	1
	Phonetic Aspects of Prosody	L	CO2	A	1
	Prosody in Speech Synthesis	L	CO2	A	1
3	Spelling errors - Spelling Error Patterns	L	CO3	A	1
	Detecting Nonword Errors	L	CO3	A	1
	Probabilistic Models of Spelling	L	CO3	A	1
	Bayesian Method to Spelling	L	CO3	A	1
	Minimum Edit Distance	L	CO4	A	1
	The Bayesian Method for Pronunciation	L	CO4	A	1
	Decision Tree Models of Pronunciation Variation	L	CO3	A	1
	Weighted Automata	L	CO4	A	1
	Computing Likelihoods from Weighted Automata - The Forward Algorithm	L	CO4	A	1
4	Spelling errors - Spelling Error Patterns	L	CO4	A	1
	Speech Recognition Architecture	L	CO5	A	1
	Bayesian Model of Speech Recognition	L	CO5	A	1
	Hidden Markov Models	L	CO5	A	1
	Viterbi Algorithm	L	CO5	A	1
	Advanced Methods for Decoding	L	CO5	A	1
	A* Algorithm	L	CO5	A	1
	Speech Recognition Architecture	L	CO5	A	1
5	Sound Waves - Interpreting a Waveform	L	CO6	C	1
	Spectra Analysis	L	CO6	C	1
	Feature Extraction from Waveforms and Spectra	L	CO6	C	1
	Computing Acoustic Probabilities - Gaussian Models	L	CO6	C	1
	Computing Acoustic Probabilities	L	CO6	C	1
	Neural Net Models, Training a Recognizer	L	CO6	C	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN

Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	
1	Computational Phonology	8				✓			12
2	Speech Synthesis	8			✓				12
3	Models of Spelling and Pronunciation	10			✓				12
4	Speech Recognition	8			✓				12
5	Acoustic processing of speech	6						✓	12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	3-0-0-0-2	Version	25/0	Credits	3
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work</i>							
Course Code	Course Name						Course Category
M250101/AD126E	INFORMATION THEORY						PE 2

COURSE OBJECTIVES	
1	To introduce the mathematical foundations of information theory for modern communication systems
2	To develop fundamental knowledge in concepts such as entropy, mutual information, source and channel coding, continuous sources and channels, and rate-distortion theory
3	To enable learners to apply appropriate coding techniques for various communication applications

COMPETENCY STATEMENTS	
CC1	Demonstrate the ability to model and analyse information sources and design efficient source and channel coding schemes for reliable communication.
CC2	Demonstrate the ability to interpret and utilize advanced concepts such as continuous sources, Gaussian channels, and rate-distortion theory to enhance the performance of modern communication systems.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	CC Mapping	Cognitive (C)
CO 1	Apply entropy and mutual information concepts to analyse memoryless and Markov sources.	CC1	A
CO 2	Apply source coding techniques to construct efficient codes for data compression and demonstrate the role of Shannon's Source Coding Theorem in defining compression limit.	CC1	A
CO 3	Apply channel coding techniques to design reliable codes and demonstrate the significance of Shannon's Channel Coding Theorem in achieving error-free communication.	CC1	A
CO 4	Apply the concepts of differential entropy and mutual information to analyse continuous sources and Gaussian communication channels.	CC2	A
CO 5	Apply the rate-distortion function and related theorems to study the trade-off between compression efficiency and distortion in information transmission	CC2	A
CO 6	Apply information theory principles to design coding approaches for efficient communication in real-world systems.	CC1, CC2	A
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	3	-	2	-	2	-	-
2	3	-	3	2	2	-	-
3	3	-	3	3	2	-	-
4	3	-	3	-	2	-	-
5	3	-	3	-	-	-	-
6	3	2	3	3	2	2	2
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - "-"</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
							Theory			Practical			Total
L	T	J	P	30	70	3	CIA	ESE	Total	CIA	ESE	Total	
3	0	0	0							40	60	100	

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Introduction to Entropy	Entropy- Memoryless sources - Markov sources Entropy of a discrete random variable - joint, conditional and relative entropy - mutual Information and conditional mutual information - Chain relation for entropy, relative entropy and mutual information	12
2	Lossless source coding	Uniquely decodable codes - Instantaneous codes, Kraft's inequality - Optimal codes - Huffman code- Shannon's Source Coding Theorem.	7
3	Channel coding	Shannon's Channel Coding Theorem and its converse - Channels with feedback - Joint source channel coding Theorem.	7
4	Continuous Sources and Channels	Continuous Sources and Channels - Differential Entropy - Joint, relative and conditional differential entropy - Mutual information- Waveform channels- Gaussian channels.	7
5	Rate Distortion Theory	Introduction - Rate Distortion Function - Properties - Continuous Sources and Rate Distortion measure - Rate Distortion Theorem - Converse - Information Transmission Theorem - Rate Distortion Optimization.	7

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Micro Project – Data interpretation	14
2	Review article	14
3	Channels with feedback	2

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Elements of Information Theory	T. Cover and Thomas	John Wiley & Sons
2	Information Theory and Reliable Communication	Robert Gallager	John Wiley & Sons
Reference			
Sl. No.	Title of Book	Author	Publication
1	The theory of information & coding	R. J. McEliece	Addison Wesley Publishing Co.
2	Rate Distortion Theory a Mathematical Basis for Data Compression	T. Bergu	Prentice Hall Inc
3	Coding and Information Theory	R. W. Hamming	Prentice Hall Inc
Web Resource			

1	https://www.youtube.com/watch?v=YJMX161E318	NPTEL	
2	https://onlinecourses.nptel.ac.in/noc20_ee96/preview	NPTEL	

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	CO	Learning Domain Level	Hours
				C	
1	Entropy - Memoryless sources	L	CO1	U	2
	Markov sources	L	CO1	U	2
	Entropy of a discrete random variable	L	CO1	A	2
	Joint, conditional and relative entropy	L	CO1	A	2
	Mutual information and conditional mutual information	L	CO1	A	2
	Chain relation for entropy, relative entropy and mutual information	L	CO1	A	2
2	Uniquely decodable codes	L	CO2	U	1
	Instantaneous codes	L	CO2	U	1
	Kraft's inequality	L	CO2	A	1
	Optimal codes - Huffman code	L	CO2	A	2
	Shannon's Source Coding Theorem	L	CO2	A	2
3	Introduction to channel coding	L	CO3	U	1
	Shannon's Channel Coding Theorem and its converse	L	CO3	A	2
	Channels with feedback	SS	CO3	U	2
	Joint source channel coding Theorem	L	CO3	A	2
4	Continuous Sources and Channels	L	CO4	U	2
	Differential Entropy	L	CO4	A	1
	Joint, relative and conditional differential entropy	L	CO4	A	1
	Mutual information	L	CO4	A	1
	Waveform channels	L	CO4	U	1
	Gaussian channels	L	CO4	A	1
5	Introduction to rate distortion theory	L	CO5	U	1
	Rate Distortion Function – Properties	L	CO5	U	1
	Continuous Sources and Rate Distortion measure	L	CO5	A	1
	Rate Distortion Theorem	L	CO5	A	1
	Converse of rate distortion theorem	L	CO5	A	1
	Information Transmission Theorem	L	CO5	A	1
	Rate Distortion Optimization	L	CO5	A	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN				
Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)	Total Marks

			R	U	A	An	E	C	
1	Introduction to Entropy	12		✓	✓				12
2	Lossless source coding	7		✓	✓				12
3	Channel coding	7		✓	✓				12
4	Continuous Sources and Channels	7		✓	✓				12
5	Rate Distortion Theory	7		✓	✓				12

This ToS shall be treated as a general guideline for students and teachers for distribution of marks.

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity – Review article	15
Internal Examination	10
Course Project – Micro Project	15
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	2-0-0-0-1	Version	25/0	Credits	2
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code		Course Name			Course Category		
M250902/CN100S		RESEARCH METHODOLOGY & IPR			GENERAL COURSE		

COURSE OBJECTIVES	
1	Approach research projects with enthusiasm and creativity.
2	Conduct literature survey and define research problem.
3	Adopt suitable methodologies and tools to design experiments, develop models, analyze data, and validate research findings.
4	Deliver well-structured technical presentations and write technical reports.
5	Evaluate publication quality and Publish/Patent research outcome.

COMPETENCY STATEMENTS	
CC1	Conduct Independent Research – Demonstrate the ability to plan and execute research projects from problem identification to dissemination of results, while adhering to ethical guidelines.
CC2	Communicate Research Effectively – Present research findings clearly and persuasively through well-structured written documents and engaging oral presentations tailored to diverse audiences.
CC3	Protect and Publish Intellectual Work – Select appropriate publication avenues, evaluate their quality using recognized metrics, and apply Intellectual Property Rights principles to safeguard innovations.

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	Competency Mapping	Cognitive (C)
CO 1	Approach research projects with enthusiasm and creativity. (Cognitive Knowledge Level: Understand)	CC1	U
CO 2	Conduct literature survey and define research problem. (Cognitive Knowledge Level: Apply)	CC1	A
CO 3	Adopt suitable methodologies and tools to design experiments, develop models, analyze data, and validate research findings. (Cognitive Knowledge Level: Apply)	CC1	A
CO 4	Deliver well-structured technical presentations and write technical reports. (Cognitive Knowledge Level: Create)	CC2	C
CO 5	Evaluate publication quality and Publish/Patent research outcome. (Cognitive Knowledge Level: Evaluate)	CC3	E
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	PROGRAM OUTCOMES (PO) CORRELATION MATRIX						
	PO						
	1	2	3	4	5	6	7
1	3	2	2	1	1	3	2
2	3	2	2	2	2	2	1
3	3	2	3	3	3	2	1
4	2	3	2	1	1	2	1
5	3	3	3	2	3	2	2

Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”

TEACHING AND ASSESSMENT SCHEME													
Teaching Scheme / Week				Self-Learning (S) / Semester	Total Hours / Semester	Credits C	Examination Scheme						
L	T	J	P				Theory			Practical			Total
							CIA	ESE	Total	CIA	ESE	Total	
2	0	0	0	10	44	2	40	60	100				100

L: Lecture (One unit is of one-hour duration), **T:** Tutorial (One unit is of one-hour duration), **P:** Practical (One unit is of one-hour duration), **J:** Project (One unit is of one-hour duration), **S:** Self-Learning & Team Work (One unit is of one-hour duration), **CIA:** Continuous Internal Assessment, **ESE:** End Semester Examination

SYLLABUS (Major Topics)			
Module	Title	Major Topics	Contact Hours
1	Introduction to Research Methodology	Meaning of Research, Research process, Research ethics, Thinking skills	6
2	Literature Survey and Problem Definition	Literature survey process, Sources of literature, Identifying research gaps and formulating research objectives/hypotheses.	9
3	Experimental and Modelling Skills	Principles of experimental design, Scientific method, Mathematical and computational modelling approaches. Validation and verification of results.	5
4	Effective Communication	Principles of technical writing, Oral presentation skills, Types of intellectual property, Research metrics-Journal Level	6
5	Publication/Patents	Types of intellectual property, Research metrics-Journal Level	8

SELF-LEARNING / TEAM WORK		
Sl. No	Self-learning / Team Work Description	Hrs/Semester
1	Write a summary of “You and Your Research”-by Richard Hamming	1
2	Read a research paper of their interest and summarize it .	3
3	Make a study about tools of literature management and present it.	2
4	Conduct a study of the documentation tool -LaTeX	1
5	Peer Review Process and Journal Selection tools -Group Activity	1
6	Open access vs. subscription-based publishing -Prepare a report	1
7	Conduct a study and prepare a report about various research visibility tools.	1

SUGGESTED LEARNING RESOURCES			
Text Book			
Sl. No.	Title of Book	Author	Publication
1	Research Methodology: Methods and Techniques	C.R. Kothari & Gaurav Garg	New Age International, 4th Ed., 2019.
2	Design and Analysis of Experiments	Montgomery, D.C	Wiley, 9th Ed., 2017
3	Applied Multivariate Statistical Analysis	Johnson, R.A., Wichern, D.W.	Pearson, 6th Ed., 2014.
4	The Craft of Scientific Writing	Michael Alley	Springer, 4th Ed., 2018
5	Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets	Deborah E. Bouchoux	Cengage Learning, 6th Ed., 2020.

Reference			
Sl. No.	Title of Book	Author	Publication
1	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications, 5th Ed., 2022.
2	Writing Your Thesis	Paul Oliver	Sage Publications, 4th Ed., 2014
3	Intellectual Property Rights: Unleashing the Knowledge Economy	Prabuddha Ganguli	McGraw-Hill, 2nd Ed., 2011.
Web Resource			
1	https://nptel.ac.in/courses/12110600		
2	https://ocw.mit.edu		
3	https://www.youtube.com/watch?v=6BArSbZ2Gcw		

DETAILED SYLLABUS					
Module	Topic	Mode of Delivery	COs	Learning Domain Level	Hrs
				C	
1	Meaning and significance of research, Types of research	Lecture	CO1	U	1
	Characteristics of good research, Research process	Lecture	CO1	U	1
	Role of research in technological and societal development.	Lecture	CO1	U	1
	Thinking skills: Levels and styles of thinking, common-sense and scientific thinking, examples, logical thinking, division into sub-problems, verbalization and awareness of scale.	Lecture	CO1	U	1
	Creativity: Some definitions, illustrations from day to day life, intelligence versus creativity, creative process, requirements for creativity	Lecture	CO1	U	1
	Motivation for research: Motivational talks on research: "You and Your Research"- Richard Hamming	Tutorial (Self-Study)	CO1	U	1
2	Literature survey process: Planning, searching, screening, analyzing, and synthesizing.	Lecture	CO2	U	1
	Information gathering – reading, searching and documentation, types of literature, Sources of literature	Lecture	CO2	U	1
	Integration of research literature and identification of research gaps	Lecture	CO2	U	1
	Attributes and sources of research problems, problem formulation, Research question, multiple approaches to a problem	Lecture	CO2	U	1
	Problem solving strategies – reformulation or rephrasing, techniques of representation, Importance of graphical representation, examples. Defining research scope and limitations.	Lecture	CO2	U	1
	Tools for literature management: Mendeley, Zotero, EndNote.	Tutorial (Self-Study)	CO2	A	1
	Identify a standard research paper in respective area and summarize it based on the problem addressed, methods used, advantages, disadvantages and future directions	Tutorial (Self Study)	CO1	A	1
3	Scientific method, role of hypothesis in experiment, units and dimensions, dependent and independent variables, Principles of experimental design: Control, randomization, replication.	Lecture	CO3	U	1

	Precision and accuracy, need for precision, definition, detection, estimation and reduction of random errors, Statistical tools for data analysis Validation and verification of results, definition, detection and elimination of systematic errors.	Lecture	CO3	U	1
	Sampling methods and sample size determination.	Lecture	CO3	U	1
	Mathematical and computational modelling approaches. Types of models, stages in modelling, curve fitting, the role of approximations, problem representation, logical reasoning, mathematical skills.	Lecture	CO3	U	1
	Continuum/meso/micro scale approaches for numerical simulation,	Lecture	CO3	U	1
4	Preparing visual aids (figures, tables, charts) for papers and presentations.	Lecture	CO4	A	1
	Guidelines for preparation of good presentation slides.	Tutorial (Self Study)	CO4	U	1
	Oral presentation skills: Structure, delivery, handling Q&A	Lecture	CO4	A	1
	Principles of technical writing: Structure, clarity, conciseness	Lecture	CO4	U	1
	Rules of scientific writing, form, content and language, layout, typography and illustrations, nomenclature, reference and citation styles, contexts for writing – paper, thesis, reports etc.	Lecture	CO4	A	1
	Common errors in typing and documentation	Lecture	CO4	U	1
	Tools for document preparation-LaTeX.	Tutorial (self-Study)	CO4	U	1
5	Relative importance of various forms of publication, Choice of journal and reviewing process, Stages in the realization of a paper.	Lecture	CO5	A	1
	Research metrics-Journal level, Article level and Author level, Plagiarism and research ethics.	Lecture	CO5	U	1
	Introduction to IPR, Concepts of IPR, Types of IPR	Lecture	CO5	U	1
	Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, trade secrets	Lecture	CO5	U	1
	Patents- Concept, Objectives and benefits, features, Patent search, filing process, and case studies in India & abroad.	Lecture	CO5	An	1
	Peer-review process and journal selection.	Tutorial (Self Study)	CO5	U	1
	Open access vs. subscription-based publishing.	Tutorial (Self Study)	CO5	U	1
	Research visibility: ORCID, ResearchGate, Google Scholar profiles.	Tutorial (Self-study)	CO5	U	1

TABLE OF SPECIFICATIONS (ToS) FOR QUESTION PAPER DESIGN									
Module	Module Title	Teaching Hours	Distribution of Marks (Revised Bloom's Level)						Total Marks
			R	U	A	An	E	C	

1	Introduction to Research Methodology	6	✓	✓	-	-	-	-	6
2	Literature Survey and Problem Definition	9	-	✓	✓	-	-	-	6
3	Experimental and Modelling Skills	5	-	-	✓	✓	-	-	6
4	Effective Communication	6	-	-	✓	✓	-	-	6
5	Publication/Patents	8			✓	✓	-	-	6
Research Paper Analysis						✓			30
<i>This ToS shall be treated as a general guideline for students and teachers for distribution of marks.</i>									

ASSESSMENT PATTERN	
Assessment	Marks
Continuous Internal Assessment	40
Learning Activity	30
Internal Examination	10
End Semester Examination	60
Total	100

COURSE DESCRIPTION							
Regulation	2025	L-T-J-P-S	0-0-0-2-2	Version	25/0	Credits	1
<i>(L- Lecture, T-Tutorial, J-Project, P-Practical, S-Self-learning & Team Work)</i>							
Course Code	Course Name					Course Category	
M250101/ AD130T	ADVANCED MACHINE LEARNING LAB					Lab 1	

COURSE OBJECTIVES	
1	To enable the learners to make use of the machine learning concepts and algorithms to derive data insights.
2	To design and implement supervised machine learning for classification and regression.
3	To implement unsupervised algorithms for clustering the data.
4	To develop machine learning based solutions to solve real world problems.

COMPETENCY STATEMENT		
Competency Statements	CC1	Apply machine learning techniques to build predictive models for real-world classification and decision-making problems
	CC2	Design and Evaluation of Machine Learning Models for Real-World Applications

COURSE OUTCOMES			
Course Outcomes (CO): At the end of this course, learners will be able to:			
CO	CO Statement	Competency Mapping	Cognitive (C)
CO 1	Apply data preprocessing techniques in predictive data analysis (Cognitive Knowledge Level: Apply)	CC1	A
CO 2	Choose suitable model parameters for different machine learning algorithms and evaluate the model performance (Cognitive Knowledge Level: Analyse)	CC1	An
CO 3	Design appropriate machine learning models to solve problems of various domains and analyse the performance (Cognitive Knowledge Level: Analyse)	CC2	An
CO 4	Build predictive models to solve real world problems and evaluate their performance. (Cognitive Knowledge Level: Create)	CC2	C
Cognitive (Revised blooms Level): - R: Remember; U: Understand; A: Apply; An: Analyse; E: Evaluate; C: Create			

CO	Program Outcomes (PO) Correlation Matrix						
	PO						
	1	2	3	4	5	6	7
1	2	-	-	1	-	1	-
2	2	1	-	1	1	1	-
3	3	2	2	2	2	2	-
4	3	2	2	2	2	2	1
<i>Correlation levels: 1 - Low; 2 - Medium; 3 - High; No Correlation - “-”</i>							

TEACHING AND ASSESSMENT SCHEME

Teaching Scheme / Week					Credit	Hours / Semester	Examination Scheme		
							Practical		
L	T	J	P	S	C	CIA	ESE	Total	
0	0	0	2	2	1	30	100	0	100

L: Lecture (One unit is of one-hour duration), T: Tutorial (One unit is of one-hour duration), P: Practical (One unit is of one-hour duration), J: Project (One unit is of one-hour duration), S: Self-Learning & Team Work (One unit is of one-hour duration), CIA: Continuous Internal Assessment, ESE: End Semester Examination

PRACTICAL SYLLABUS					
Sl. No.	Topic	Objective	COs	Learning Domain Level	Hrs
				C	
1	Google Colab	To familiarize students with the Google Colab platform for developing and executing Python code in a cloud-based notebook environment.	CO1	U	2
2	Python Data Structures	To reinforce understanding of fundamental Python data structures (lists, dictionaries) and their use in handling data for machine learning tasks.	CO1	U	2
3	Familiarization of numpy and pandas' packages	To gain proficiency in using numpy for numerical operations and pandas for data manipulation and analysis.	CO1	U	2
4	Data preprocessing.	To apply essential data preprocessing techniques to clean and transform raw data into a suitable format for machine learning algorithms.	CO1	A	2
5	Decision tree based ID3 algorithm.	To understand the fundamental mechanics of the ID3 algorithm, including entropy and information gain calculation for building a decision tree.	CO2	A	2
6	Naïve bayesian classifier	To implement and evaluate a Naïve Bayes classifier, understanding the "naïve" conditional independence assumption.	CO2	An	2
7	Naïve bayesian Classifier for document classification	To apply the Naïve Bayes algorithm to text data, understanding the Bag-of-Words model.	CO2	An	2
8	k-means clustering	To understand and implement the k-means clustering algorithm for unsupervised learning.			
9	k-Nearest Neighbour algorithm .	To implement the k-NN classification algorithm and understand the impact of hyperparameters like 'k' and distance metrics.	CO3	A	2
10	Cross validation	To use cross-validation to get a more reliable estimate of a model's performance and generalizeability.	CO3	An	2

11	Regression model	To build a linear regression model to predict a continuous target variable and evaluate its performance.	CO3	A	2
12	Support Vector Machine.	To understand the concept of maximum margin classification and implement SVM for both linear and non-linear separable data.	CO3	A	2
13	Neural Networks	To understand the core components of a neural network, including forward propagation, activation functions, and backpropagation.	CO3	A	2
14	Convolutional Neural Networks	To build, train, and evaluate a Convolutional Neural Network (CNN) for image classification.	CO4	C	2

SELF-LEARNING / TEAM WORK

Sl. No	Self-learning / Team Work Description	Hrs
1	Python	30

SUGGESTED LEARNING RESOURCES

Text Book

Sl. No.	Title of Book	Author	Publication
1	Hands-On Machine Learning with Scikit-Learn and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems	Aurélien Géron	O'Reilly
2	Deep Learning	Goodfellow, I., Bengio, Y., and Courville, A.,	MIT Press, 2016.

Reference

Sl. No.	Title of Book	Author	Publication
1	Data Mining Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei.	Third Edition. Morgan Kaufmann
2	Pattern recognition and machine learning.	Christopher M. Bishop.	Springer 2006

Web Resource

1	Python for Data Science, Prof. Ragunathan Rengasamy, NPTEL, IIT Madras
2	Machine Learning and Deep Learning - Fundamentals and Applications, Prof. M. K. Bhuyan, NPTEL IIT Guwahati

ASSESSMENT PATTERN

Assessment	Marks
Continuous Internal Assessment	100
Continuous Lab Evaluation	60
Internal Examination	40
Total	100